INDEXED

International Marine Engineering

FEBRUARY, 1912

The Italian Turbine Passenger Steamer Citta di Palermo

BY DAGNINO ATTILIO

This steamer has just now finished twelve months of service between Naples and Palermo for the Italian State's Railway Department. She is a handsomely fitted and well-appointed vessel, and was designed and built in the shipbuilding yards at Palermo. She is a triple-screw turbine steamer of the following dimensions and particulars:

Length over all	365 feet.
Length between perpendiculars	348 feet.
Breadth, molded	47 feet.

THE CITTA DI PALERMO, ITALY'S FIRST TURBINE-DRIVEN PASSENGER SHIP

Depth, molded	30 feet.
Displacement	3,445 tons.
Shaft horsepower	12,000
Speed in service	20 knots.
Designed speed on trial	22 knots.

Mild steel was used in the construction of the vessel, which fulfills the requirements of Italian shipbuilding and ship surveying regulations. The hull is divided below the main deck into thirty-six watertight compartments, forming double-bottom, peak tanks, holds, oil bunkers, deep tanks, fresh water tanks, engine and boiler rooms, steering-engine room, etc., which make the ship practically unsinkable, even if one or two compartments are flooded.

The propelling machinery, consisting of three sets of Parsons turbines, was manufactured by Messrs. Ansaldo at Sampierdarena. The high-pressure turbine is on the center shaft, and one low-pressure turbine incorporated with an astern turbine on each of the wing shafts. The propeller shafting is of steel turned all over, and two plummer blocks are fitted to each length of shafting. The propellers are of the solid type of manganese bronze, accurately balanced and polished all over, so as to reduce vibration and friction to a minimum.

The handles of all valves for the ahead and astern turbines are accessible from the starting platform at the forward end of the engine room, so that an engineer can have complete control of all the machinery. The condensers, of the Uniflux type, are placed alongside the after end of the low-pressure turbines, and are built of steel plates, with strong cast-iron end chambers, with ample cooling surface of 9,000 square feet, and so arranged that the circulating water passes twice through the condensers entering at the bottom. Each condenser is connected to one of the low-pressure turbines by a large steel eduction pipe. The cooling water is supplied to the condensers by two large centrifugal circulating pumps, each driven by a separate reciprocating engine, 11 1/16 inches in diameter by 11 1/16 inches stroke, the suction and delivery pipe being 23 inches diameter; the wheel is 44 inches in diameter and runs at 225 revolutions.

The air pumps are of Weir-Dual's type for wet and dry air suctions, the diameter of each pump is 22 inches and the stroke 16 inches. Pumps are also supplied for forced lubrication of the bearings, and for oil-cooling purposes. There is a full complement of pumps for the bilge, sanitary and fresh-water service of the ship. There are two pairs of Weir's

double-acting feed pumps, each pair being capable of supplying the boilers when the turbines are exerting their full power. The exhaust steam from the auxiliaries is led into a surface heater, through which the feed-water is passed on its way to the boilers. The feed pumps have 13 inches diameter and 26 inches stroke; they are fitted in the forward end of the engine room, together with feed-water filters of the gravitation type. An auxiliary condenser with independent air and circulating pumps is also fitted at the forward end of the engine room.

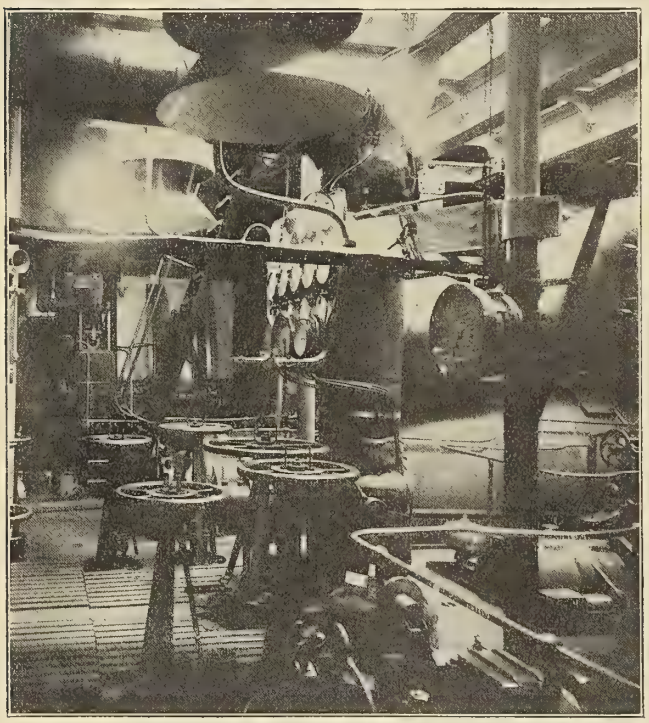
There are also two large self-lubricating steam-driven dynamo sets. The distilling plant consists of a Bousigueri evaporator, capable of producing from sea-water 20 tons of fresh water per twenty-four hours.

Steam is supplied by ten single-ended boilers, 14 feet 1¼ inches diameter by 11 feet 2⅝ inches long, with three Morison furnaces, 3 feet 10½ inches outside and 3 feet 7⅜ inches inside diameter. The working pressure is 170 pounds per square inch, the grate area 614 square feet for the ten boilers, length of grate 5 feet 9⅜ inches, and heating surface 26,050 square feet. There are 372 tubes in each boiler, with an outside diameter of 2¾ inches and 8 feet 2½ inches in length. The steam chamber contains 3.531 cubic feet, and the stop valve is 4⅝ inches in diameter.

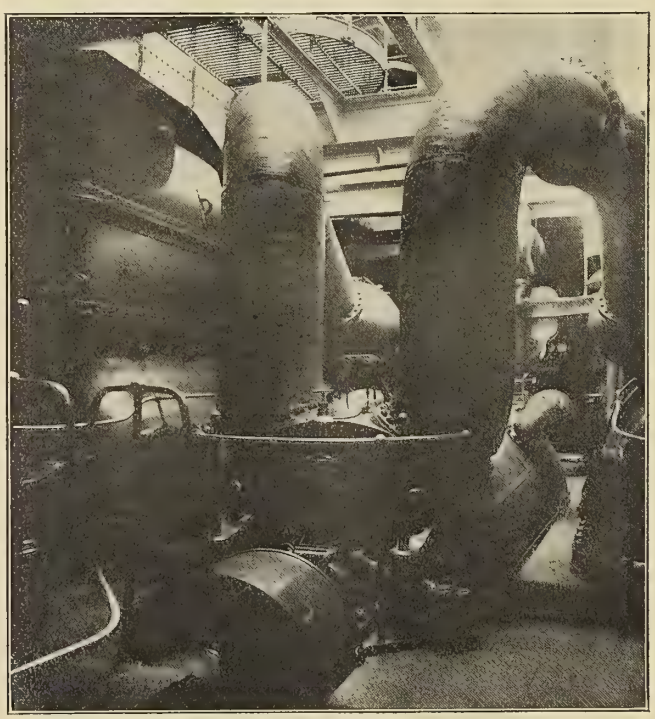
The boilers are arranged in three compartments; four in the central and aft compartments and two in the forward compartment; there are two circular funnels which are double, the space between the inner and outer being utilized for ventilating the boiler rooms and stokeholds. The boilers work under Howden's forced draft system, air being provided by five large fans, driven by suitable closed self-lubricating steam engines. See's ejectors are fitted, one for each group of boilers, while for harbor duty two steam oil-heating engines are provided.

The propellers are three-bladed, of 6 feet 6¾ inches in diameter, 5 feet 10 11/16 inches pitch; projected surface for three blades, 20 square feet; developed surface, 22 square feet.

Progressive endurance and full-speed trials were carried out with the vessel, her performance being exceptionally satisfactory throughout. On the full-speed trial she attained a speed of 23.1 knots as the mean of means of six hours of running on the measured mile, from Cape Gallo and Cape Zafferano.



STARTING PLATFORM IN THE ENGINE ROOM OF THE CITTA DI PALERMO



AFTER END OF THE CITTA DI PALERMO'S MAIN TURBINES

Navigable Model Tests

In view of the valuable results obtained from tests of a navigable model at the Massachusetts Institute of Technology during the last two years, it is gratifying to find that a substantial fund has been received by the Institute to continue and enlarge the experimental work of this kind. Money has been advanced by two prominent New York yachtsmen, Clinton H. Crane and Arthur Curtis James. The former is well known as a designer in yachting circles and the latter is a former commodore of the New York Yacht Club.

The tests will be made on tugboat models, and, according to Prof. C. H. Peabody, under whose supervision the tests will be made, the model itself will be constructed entirely in the shops at the Institute, the work being finished in the spring and the experiments carried out during the summer. The machinery formerly used in the *Froude,* described in the December, 1911, issue, will be transferred to the new tugboat model, and the tests will be made in the Charles River basin in the same manner as was used with the earlier model.

Prof. Peabody states that there are two reasons for taking up the work on tugboats:

First, that the problem of towing appears to have received scant attention, and

Second, that results obtained with the *Froude,* which have not yet been published, show unexpected and important results from such experiments.

It is expected that the work with the tugboat and that already done in towing with the *Froude* will enable placing the towing problem in a clear light. This kind of work can be carried out with certainty and precision, and it is apparently of such a nature that it cannot be accomplished in a model-towing basin.

Marine Gas Engines: Their Design and Application—VI

BY E. N. PERCY

(*Concluded from page* 10, *Vol. XVII.*)

Heads

At this stage of gas-engine development it is generally acknowledged that large engines must have separate heads. These are made in many forms; they may be a simple water-cooled plate on the head of the engine or a tip just carrying valve gear, etc., or it may form the entire half of the cylinder. In one very successful design the head and cylinder liner are cast in one piece, the outer end liner being turned 1/1000 inch smaller than the cylinder casting and having grooves for rubbing, sliding joints. At the upper end of the head is an ordinary flange, by means of which a water joint is made with a gasket in the usual manner.

A gas-engine cylinder head, particularly of the vertical type, containing valves, inlet and exhaust passages, pockets for ignition devices, etc., makes one of the most complicated pieces of coring with which the founder has to deal. Especially as there should be as few as possible all passages and pockets should be surrounded with water, and the iron forming the walls of each should be kept apart by cores at all points, if possible.

There is probably more trouble with cylinder heads than any other known thing in the mechanical construction of a gas engine. Some of these difficulties are leakage, trouble with gaskets, distorted valve seats, distorted valve guides and poor castings. These troubles are due in part to poorly distributed metal, one portion of the head being of a much heavier construction than another portion, or the walls of passages are allowed to intersect unnecessarily, forming large lumps of metal. If the exhaust valve or the exhaust passage is not entirely surrounded by water trouble is almost certain to result.

The holding-down bolt for the head should never be put through the exhaust passage if it can be helped, or if absolutely necessary should be water-cooled.

With both cylinders and heads of a gas engine it is very important to see that they are absolutely clean from core material. Frequently a batch of burnt or hidden coring will be left in a jacket or in a head, resulting in a hot spot in the cylinder or trouble in the head which cannot be accounted for. Any well-defined hot spot in cylinder or head may be traced through to core material or to poor design; that is to say, so much iron has been put at this particular point that there is not enough water to cool this spot.

It is usual in large gas engines to arrange the head for the four important connections of a gas engine, namely, the inlet pipe, the exhaust, the outgoing water and the ignitor. It is usually crowded for room; the valves are seldom exactly as large as they should be in practical engines, although it is quite possible to make them so, and it is seldom properly cored with all chambers and passages freely able to expand and separated from each other with water on all sides of them. Hence it is easy to see why so much trouble is had with the cylinder heads and why many peculiar designs are adopted to get room for the various connections or apparatus. Among these might be mentioned diagonal valves, pockets and convexed heads. The latter and dome pistons are to be looked upon with suspicion as giving the poorest form of combustion chamber, dome heads and cup pistons giving equal strength in every way with a far better combustion chamber.

Facings for inlet pipes, if well machined, need no gasket, as such air as leaks in will have little effect on the mixture; in any case a beneficial effect. Facings for exhaust pipes should either have ground joints or have fireproof gaskets.

Both passages in the head should be as large and roomy as possible, as should also the valve chamber, in order that a gas traveling in through the comparatively small pipes may be gathered, to some slight extent, between strokes and through the early part of the suction stroke when the velocity of the piston is low.

The placing of the ignitor is a matter governed entirely by practice. Theoretically, it should be placed in the center of the combustion chamber; practically, if so placed, it would not only be soon destroyed by the heat but its delicate parts would be rendered useless almost instantly, and heating up would continually pre-ignite the charges, even as they were being drawn into the cylinder. Hence the ignitor is usually placed at the side of the cylinder or in the head, or even in a water-cooled pocket, some distance back in the head in which it ignites the gas, causing a little flame to shoot out of the pocket to the center of the charge. The water connections to the head should never be through the joint, because it is difficult, if not impossible, to make a joint that will meet the dual conditions of highly-heated gases and cold water. The water may be taken from the cylinder and discharged into the exhaust pipe, as in the case of marine engines, or there may be a cold-water main and hot-water main; the cold water discharging to the various parts of the engine through pipe connections, the hot water issuing from these pipes into funnels in which the flow may be seen and felt as temperature is taken, etc. Also, the overflow pipe will be provided with plug cocks to adjust the flow and temperature for each part of the engine.

Valves

The area of the valves is a matter of varied discussion, and is one in which there is much latitude. For small high-speed automobile type engines it is necessary to make the valves as large as can possibly be put in the cylinders with as little lift as possible, in order to favor the extreme speed of the mechanism.

The velocity of the mixture through the inlet valve varies in practice from 5,000 feet per minute to 20,000 feet per minute, and through the exhaust valve it will frequently go double this amount. The exact amount, of course, is not known, but it is only necessary to observe the fine wire lines across the sides of the valves of many engines to know that the velocities are entirely too high, even if the power of the engine is not materially reduced. With the inlet valve working at a velocity not to exceed 8,000 feet per minute, and the exhaust valve of equal size or even larger, it is perfectly reasonable to suppose that the expanded gases are greater in volume and exit at tremendous velocities and temperatures, often still burning, scoring the valve and seat, heating and deteriorating the stem, causing rapid deterioration of the valve. It is the author's opinion that exhaust valves should be made very much larger than at present, or if this be impracticable that two exhaust valves should be provided.

The lift of the annular valve should be approximately one-fourth of its diameter to obtain full opening of its port, but in case of large valves this places a strain on the mechanism from the acceleration and inertia stresses, which can be much decreased by increasing the size of the valve and reducing the lift, this being especially true with high-speed engines.

Valve springs have very hard work to do, and it should all be well within their elastic limit. This means, in plain words, long springs, many coils of very heavy wire, giving in turn long valve stems with an opportunity to use long guides upon them. The pressure necessary for a valve spring should be

proportional to its work, namely, that of keeping the valve against the tapit at all parts of its stroke, or, in other words, to overcome the inertia of the valve, particularly at the inner end of the valve stroke. By calculating the acceleration and velocity of the valve at the end of its stroke it is possible to know just what amount of work the spring is to do. In addition to this it should be remembered that the spring must overcome the inertia of the valve at all points of movement on the return stroke, and must come to an instantaneous stop from its highest velocity as it seats. Some very complicated pieces of mechanism are designed to reduce this velocity just at the point of seating, but their theoretical good effect has never overbalanced their complication, and practice has shown that it is perfectly safe and much cheaper to seat the valve at highest velocity without a guard to acceleration stress.

It is generally conceded that both valves should be mechanically moved on all types of engines, and that it primarily is a means of saving to make them otherwise. A cam machine, from its very nature, is neater, and the author is of the opinion that eccentrics can and will be used to operate gas-engine valves in the near future by the aid of acceleration bell cranks so arranged as to get all equal and open relatively slowly.

The cooling of the inlet valve has never been a serious problem, as the incoming mixture has always been sufficient for the purpose. The exhaust valve is a serious problem on all engines, and if one can be removed quickly from an engine which has been running for several hours consecutively it will be found to appear red-hot; referring, of course, to valves which are not cooled.

With large engines having valves upwards of 4 inches in diameter it is customary to make them water-cooled. The greatest difficulty with water-cooled valves is the water joint. This has been tried variously with telescope joints, pendulum joints, etc. The most satisfactory, probably, is a short piece of hose; it is practical, works perfectly and looks neat, especially if bound on the ends with a brass binding or ferrule.

Many new devices have been used with gas-engine valves, either in the form of insertible rings or bushings or a complete cage in which the valve works. A serious objection to the valve cage has always been the double joint necessary, but since the advent of copper gaskets the double joint has been found an entirely practical proposition. The most modern practice with valve cages is to have them water-cooled, thus having the valve in a removable water-cooled cage, in which it can be ground, lined up and otherwise looked after.

Unless carefully water-cooled the valve is more or less apt to distort, especially in large engines, but when carefully jacketed with water it makes an ideal piece of construction, and is now extensively used on high-grade engines.

In Germany, and also in America, many makers of high-grade engines of the stationary type have their valves erected in cages, the advantage being obvious. There are many kinds of cages, and every firm that has taken them up has passed through a costly but useful experiment, it being by no means as simple to construct valve cages as it appears. The designer, in putting in his first valve cages, will probably find it impossible to keep the valves ground in, because of the distorting of the seat, due to the cage being unsymmetrical or one side being hotter than the other, or the joints being improperly made, or the cage being too close or too slack to fit in the tube; also, he may find that the valve stem binds, due to its being cooler on one side than on the other, or to the guide being insufficiently cooled. All these are problems which can be settled only by experiments of the most expensive kind, but as soon as thoroughly developed and understood by a firm, a valve cage is the most valuable asset a gas-engine man can have.

Piston

Pistons are made in various forms, but in general are much heavier than with steam engines, and must be more carefully designed as regards distribution of metal, etc.

The gas-engine piston works under a much wider range of temperature, under higher pressures, greater shocks and with mediums which escape much more easily than steam, and in the smaller-size engines are not water-cooled. With the diagonal, single-acting gas engine it has been general practice to provide a bucket piston. On either horizontal or vertical engines, late practice has tended strongly towards the use of pistons so constructed that the wrist pin is external to the cylinder, and piston is in plain view and easily accessible for adjustment, lubrication and examination while running. This feature involves various constructions, ranging from an extension of the piston outside of the cylinder with large orifices on each side to an ordinary double-head piston within the cylinder, connecting with an ordinary cross-head by means of a piston rod. Besides the bucket piston we have the double-ended piston, constructed to operate on the end of the piston rod. This piston may be hollow or solid, and may or may not be water-cooled. It is found in both single and double-acting engines, and is made in various forms, namely, with flat, parallel faces, with dome faces, and occasionally with concaved faces. Bucket pistons are frequently made with concaved faces in order to give the combustion chamber an almost spherical form at the moment of ignition, also as it provides additional combustion space without lowering the wrist pin, the entire engine is somewhat shortened, also the concave piston head is stronger than a flat head.

Piston velocity in the gas engine does not vary a great deal in large, heavy engines designed primarily for durability and runs from 600 feet to 800 feet per minute. In engines designed primarily for speed and lightness, as in automobiles, motor boats and air ships, it may run as high as 2,000 feet successfully, but these high speeds call for larger pipes, finer workmanship and careful allowances for expansion.

Lubrication should be carefully attended to in all cases, but most particularly in high-speed engines. The pressures on pistons during a cycle will vary from 10 to 14 pounds negative to 300, 400 and 500 pounds positive pressure. As the average or mean effect of pressure is only 50 to 75 pounds, and the compression 75 to 100 pounds, it is easy to understand that the maximum pressures must be of short duration, and have much the same effect on the piston as a blow. As this shock usually takes place on or before the center, especially at high speed, it is easy to realize the tremendous stresses to which it is subjected. In connection to this is a special consideration of the off-set crank in addition to those hithertofore referred to. With the off-set crank the piston has attained some little velocity when the explosion takes place, and the force of the explosion can be expended with the crank at some point of perceptible moment of revolution, and this shock, instead of expending itself on brasses and piston, tends to give the engine a decided impetus ahead; also the power of explosion is received and made use of coincident with this occurrence, and the gases have lost temperature, the pressure thus being an important point, as it is only necessary to examine an average indicator card to see that this loss generally takes place with a tremendous rapidity. While the effect on the power is not probably great it will have a perceptible effect upon the economy and makes a pronounced difference in the durability of the engine, particularly so far as the piston and piston pin are concerned.

The piston rings are subject to much discussion, being a detail developed purely from practice and experience and having no rules or theoretical formulæ in any way applicable. The number of them is governed largely by the space available between the piston pin and the base of the piston, the thickness of them by the diameter of the piston and amount of strain desired, the width of them by the diameter of the piston, the

pressure for which designed and the number of rings which it is desired to lay between the piston pin and the face of the piston. In the case of the piston in which there is no pin, it is purely a matter of experience and the number which can be put between the piston faces.

Under identical conditions practice of the above details varies widely with the different forms and equally good results seem to be obtained. Patent rings of complicated or built-up construction do not seem to have survived in any form in the ring market. Probably the eccentric ring is used more than any other. Very cheap engines have those rings made with a simple diagonal slash in same, which is good enough for a practical large-size engine, but will affect the economy and compression considerably in the course of time. More careful builders cut the ring with the mortars, and the joint is carefully lapped half and half.

Eccentric rings are usually made about twice the thickness on the thick side of the thinnest side. The width may be approximately twice the average thickness, although some makers vary considerably from this. The usual method of making the rings is to turn them inside and out from the stock, leaving the outside about 1/32 inch large. Makers of cheap engines do not do this but turn the ring directly to size in the stock. The end of the stock is carefully faced and finished and the ring is cut off. The ring is then jointed and set in a chuck, carefully centered and backed against a face plate, large factories having a machine for this purpose, smaller factories or jobbers of large engines doing the work on a cut lathe. The ring is then sprung together, held in that position, carefully turned on the outside to a trifle over the diameter, and the remaining top fixed to gage. The ring is then taken to bench and the end fitted to piston.

The tension on the ring, its friction against the side of the cylinder, etc., are entirely a matter of experience, and cannot be detailed here. The rings are finished on the corners, either with a fine file or are hand-centered. It is customary with many designers to run the top of the ring through, to or over the counterbore. This is unnecessary and objectionable. In the first place, if the ring runs over the counterbore it is very apt to be collapsed by the pressure, also it gradually collects soot until the groove is full, hiding the ring and cutting the cylinder.

Practice has shown that it is only necessary to run the end of the piston over the counterbore at either end of the cylinder and the cylinder will thus be borne down and practically the same power will be obtained. The travel of the ring wears a difference between them, being a gradual taper extending from the center of the cylinder, which naturally wears largest to the counterbore and not a shoulder, as is theoretically supposed, forming at the end of the travel of the rings.

With large engines the cylinders are usually finished on the lathe with cutting tools, as with steam engines and pistons in the same manner, being of fairly loose fit with each other, between 1/32 and 1/64 inch clearance. With small engines the cylinders and pistons are carefully ground, the lower end of the piston being ground 1/100 inch larger than the upper end to allow for differences in expansion.

The grinding of large cylinders, pistons, and, for that matter also, of pins and bearings is a doubtful advantage in practical engineering. The first objection is that the cost is not counterbalanced by the result obtained, especially when one considers that the run of a few weeks or even days removes the traces of grinding and brings the pins, pistons, cylinders, etc., to a condition that could have easily been reached in the first place with lathe tools. Furthermore, in a cylinder which has been finished with a bearing tool, if a small chip be started by a sharp corner or a rough or overheated ring, and one which fits too tightly, the chip is very likely to end at one of the minute tool marks rather than score the whole length of the cylinder. Moreover, with large engines the fine fits, which can be obtained with grinding between the pistons and cylinders, do not seem desirable, as the engine works better when fit more loosely. This is due to the fact that the distortion in casting of practical designs is frequently three or four, or even more, times the limits which are obtained by this fine method of finishing cylinders.

The wrist pin has a bearing to be taken up in connection with connecting rods, but in regard to its relation with the piston some reference should be made to the best methods in use. The cheapest way to place a piston pin in any kind of pocket piston engine is to fasten it solidly to the connecting rod, and having it turn in bushings set in each side of the piston; but this is a most objectionable method, because while the pin is theoretically not subject to a great deal of wear, in actual practice it is found that its bearings have to withstand considerable. This is probably not so much due to wear as to the constant action of the piston upon it, which increases as lost motion accumulates, until the bushings receive a very considerable battering with every stroke of the engine.

One of the most satisfactory methods is to set the pin solidly in the piston and providing split brasses in the center, with a regular marine design adjustable from the lower side. It is customary to set the pin in plain bored hole with key on one side and set screws on under side, the hub on both sides.

There should be grooves for lubrication on any kind of piston, whereby the oil may creep to all parts of the piston, and in the case of pocket piston at least one snap ring should be provided below the oil grooves to keep the oil from dropping out of the cylinder. In the case of pocket pistons it is customary either to make the piston pin hollow or to drill it from end to end, and then to so drill at right angles that the lubricating oil reaches all parts of the piston pin. This lubricating oil the piston takes from the piston oil grooves. Piston rods may be put on each side of same, as in the steam engine, excepting that nuts cannot be used unless they are inside of the water-jacket or in other parts protected from the heat.

In the case of the double-acting engine the piston is also hollow and filled with water supplied through a hollow rod and carefully lubricated, usually by means of an oil lantern in the water-cooled stuffing basket.

An interesting feat in the casting of Monel metal was recently accomplished in the foundry of the Bayonne Casting Company, Bayonne, N. J., where a four-bladed propeller wheel 16 feet in diameter was cast in somewhat less than an hour. Fully 18,000 pounds of the metal was required to allow for gates and finish, the melting temperature being about 2,500 F., and the finished weight about 14,000 pounds. The wheel, because of its greater strength and freedom from corrosion, is to take the place of a steel wheel on the steamship *Madison*, of the Old Dominion Line.

The Bureau of Navigation reports that 61 sail and steam vesels of 3,113 gross tons were built in the United States and officially numbered during the month of December, 1911. About 70 percent of this tonnage consisted of steel steam vessels constructed on the Atlantic and Gulf coasts.

For the six months ending Dec. 31, 1911, the Bureau of Navigation reports 612 sail and steam vessels of 82,267 gross tons were built and officially numbered. As compared with the corresponding period in the preceding year there was a decrease of approximately 40 percent, the total tonnage built and officially numbered in the six months ending Dec. 31, 1910, being 137,568.

Twenty Thousand-Ton Pontoon Floating Dry-Dock

In a paper presnted before the nineteenth annual meeting of the Society of Naval Architects and Marine Engineers by Messrs. Frank E. Kirby and William T. Donnelly, the new marine terminal of the Grand Trunk Pacific Railway, Prince Rupert, B. C., was fully described. An abstract of this paper was published on page 5 of our January issue, which contained a description of the pier work, launching platform, power plant, boiler, blacksmith, machine and woodworking shops and the administration buildings. The main feature of the terminal, however, is a 20,000-ton pontoon floating dry dock, details of which have been reserved for publication in detail in this issue so that they can be better explained by reference to the drawings.

This dock is to have an over-all length on keel blocks of 604 feet 4 inches, a clear width of 100 feet and a width over all of 130 feet. The lifting power is the aggregate of twelve pontoons of timber construction, each 130 feet long, corresponding to the width of the dock, 44 feet wide in a direction corresponding to the length of the dock and 15 feet deep. These pontoons are to be united by steel side walls or wings 38 feet high, 15 feet wide at the bottom and 10 feet wide at the top, the walls being divided so that the whole structure may be used under ordinary conditions as three separate docks, one of six pontoons, with an over-all length of 269 feet, and two of three pontoons each, with an over-all length of 164 feet each. The largest commercial ship upon the Pacific Coast at the present time is the *Minnesota,* the outline of which is shown on the dock. This vessel would have a dead weight in ordinary unloaded condition of approximately 18,000 tons.

The machinery for pumping the dock will consist of centrifugal pumps operated by electric motors, the capacity of the equipment being sufficient to pump the entire lifting power of the dock in less than two hours. A detailed description of the pumping machinery will be given later.

The structure as a whole is secured to the shore by the engagement of clamps on the dock with a vertical truss secured to the pile platform or pier in such a way that it is free to rise and fall with the tide, and when being raised or lowered with a ship. The location of these attachments is such that when it is desired to use the dock in three separate sections, the bow section may be detached and moved around the corner of the pier work alongside the platform, and secured in the same manner as provided for in its original position. To make the other two sections available as separate docks it is only necessary to detach the middle section, comprising six pontoons, from the pier work and advance it the length of the detached section, when the sliding clamps upon the wings will coincide with those used for the previous section when the dock was operated as a whole. This will allow ample space between the center and stern sections for the overhang without interference of vessels which may be docked on them.

As the feature of a sectional dock to be used as a whole or separately is somewhat new, it is desired to call attention to the fact that the three largest commercial docks in the United States, namely, the 10,000-ton floating dry dock of the Tietjen & Lang Dry Dock Company, built in 1900, the 12,000-ton dock of the Morse Dry Dock Company, built in 1902 (both in New York harbor), and the 10,000-ton dock of the port of Portland, Portland, Ore., are sectional docks in five sections each. All of these docks are of timber construction and are giving excellent service.

Pontoons

As previously stated, the pontoons for this dock are to be twelve in number, constructed entirely of timber (Fig. 3). They are to be 130 feet by 44 feet by 15 feet deep, with a crown of 3 inches at the center, and will have fifteen trusses spaced on 3-foot centers. There will be a center watertight bulkhead 12 inches thick, and above this bulkhead the center will be reinforced for carrying keel blocks. There will be three partial bulkheads on each side to stiffen the pontoons. All diagonal braces are heavily reinforced with anchor stocks. The arch brace is made up of planking through-bolted with screw bolts, and is intended to take the reverse stresses when the dock is floating light. This is a considerable amount when it is considered that the wings are superimposed weights carried at the extreme ends of the trusses, supported by an evenly distributed pressure over the entire bottom. Six by 12-inch deck beams are worked across the upper and lower truss members, carrying the 5-inch deck and bottom planking parallel to, and reinforcing the truss members for the maximum stress. This construction also makes it possible to get in double vertical tie rods alongside of bulkheads in such a manner that they may be replaced at any time. The whole structure is made watertight by calking with white pine wedges.

To protect the exterior from toredo and other marine worms, it is first thoroughly graved with tar poisoned with arsenic, then sheathed with two layers of hair felt, each thoroughly saturated with tar and arsenic, and then with creosoted lumber, also treated with arsenic and thoroughly secured with galvanized nails. This treatment, together with the facility for inspection afforded by the possibility of detaching and docking any pontoon, has been found to give satisfactory protection.

Each pontoon will require approximately 330,000 board feet of lumber, or a total, including outrigger or prow on the end pontoons, of 4,000,000 board feet. The entire bill of lumber will be of selected grade of Oregon pine or Douglas fir.

As previously stated, it is the intention to have these pontoons built upon the launching platform under the building shed, using tools and equipment provided for the plant. Sufficient room has been allowed to build three pontoons at the same time. As soon as they are launched they will be moved into the basin between the pier and dry dock platform, and temporarily united together in correct relative position by timber clamps, when they will be ready for the erection of the steel wings.

For further information relative to the use of wood for the construction of floating dry docks, parties interested are referred to a paper on "Floating Dry Docks in the United States —Relative Value of Wood and Steel for Their Construction," appearing in the *Proceedings* for 1910 of the Society of Naval Architects and Marine Engineers.

Steel Wings

By referring to Fig. 2, showing the completed structure and the design of the wing trusses and plating, a general idea will be gained of the construction of the wings. They consist of channel and angle frames on 3-foot centers corresponding to the trusses of the pontoons, and a covering of plating varying in thickness from one-half to five-sixteenths inch. The construction is greatly facilitated by reinforcing the plating against water pressure on the outside by horizontal angles. This does away entirely with troublesome intercostal connections and gives the material used very much greater value in the construction as a whole.

By referring to the table of weights it will be seen that there are required about 2,200 tons of steel. Where the wing meets the deck of the pontoon there is a steel shoe secured to the frame of each pontoon and a corresponding shoe riveted to each frame of the wing. These are connected together by a

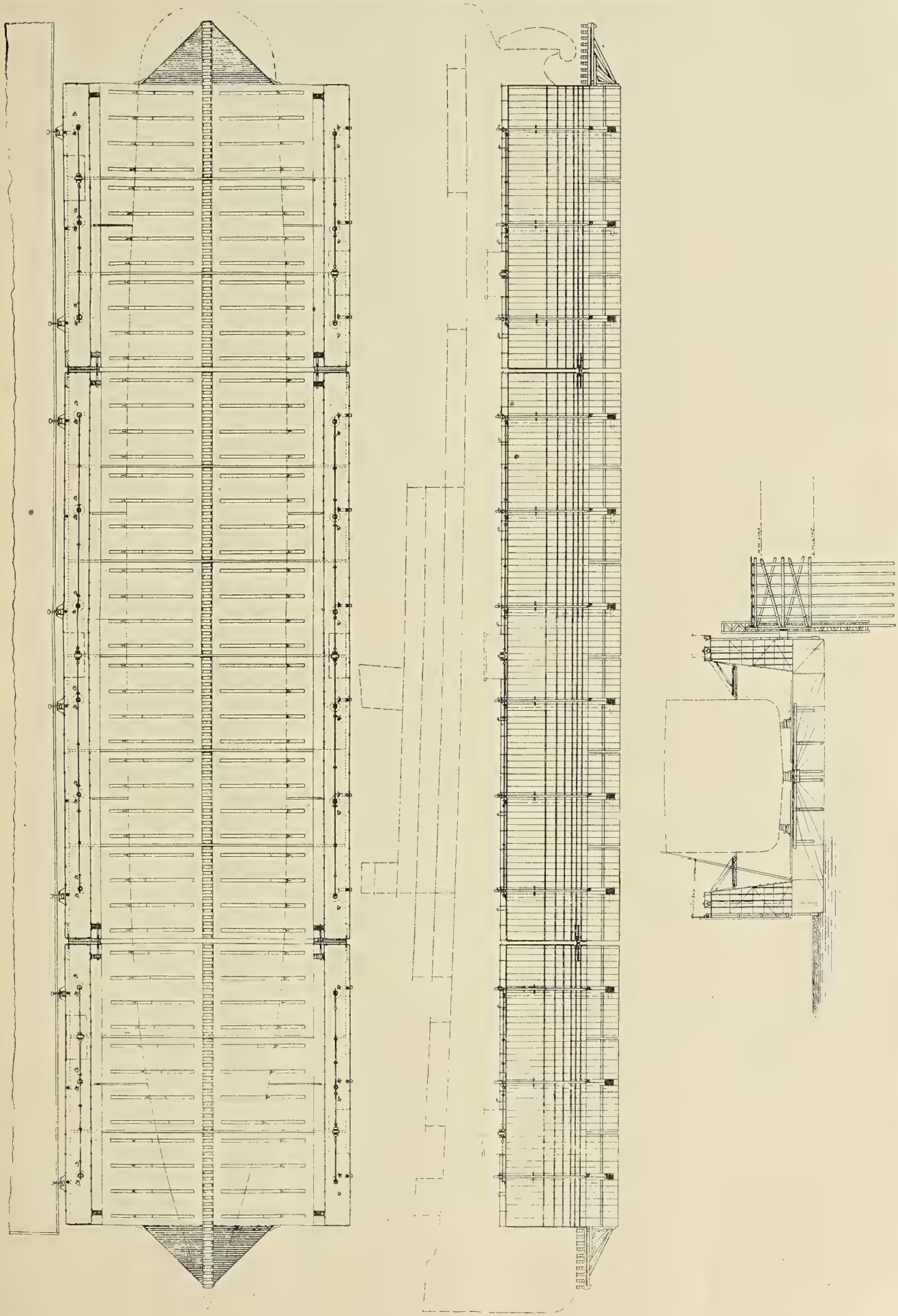


FIG. 1.—PLAN, ELEVATION AND CROSS SECTION OF 20,000-TON PONTOON FLOATING DRY-DOCK FOR THE MARINE TERMINAL OF THE GRAND TRUNK PACIFIC RAILWAY, PRINCE RUPERT, BRITISH COLUMBIA

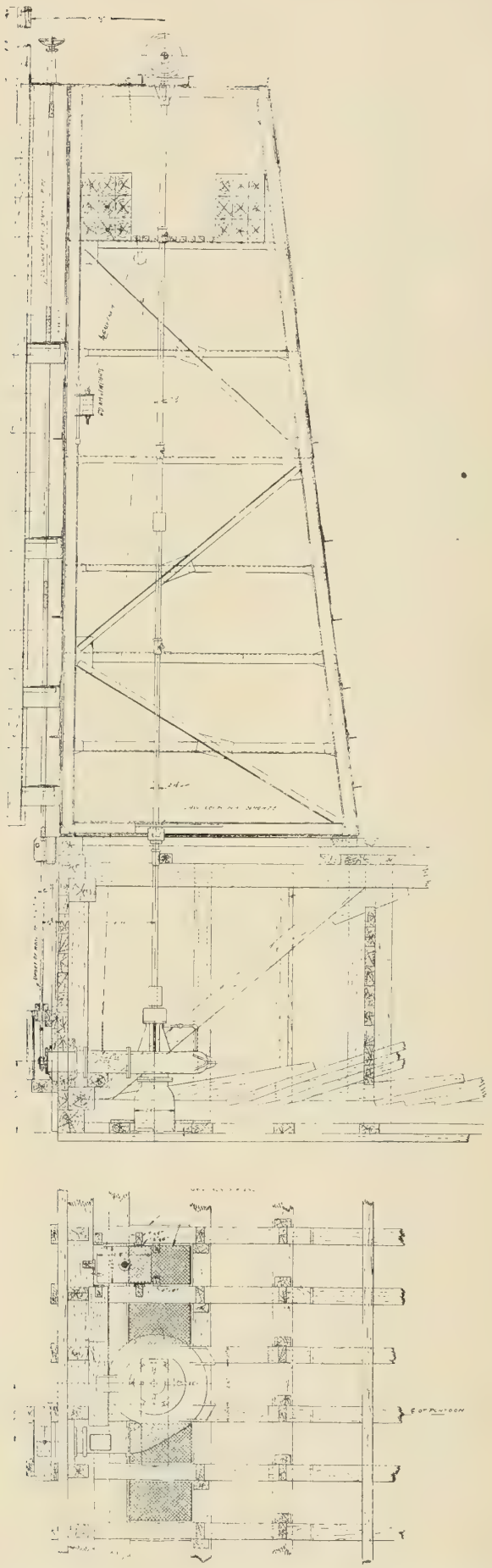


FIG. 2.—GENERAL PLAN SHOWING LOCATION OF PUMP, WING, PONTOON FLOATS AND GATE ROD PROTECTOR

steel link about 15 inches long and pins, the upper one of which is tapered one-half inch to the foot. The driving of this pin wedges the pontoon and wing together. At the point of contact the bottom of the wing is reinforced by a 12 by ½-inch plate, and made watertight by canvas packing saturated with red lead. On the outer side of the wing the method of securing is similar, except that the shoe on the pontoon is replaced by a cast steel strap through-bolted to the pontoon.

Provision is made for multiple punching on uniform centers of 3 inches and 6 inches throughout, and the intention is to have the material fabricated in Europe or the eastern part of the United States, all frames assembled and shipped by water to Prince Rupert. The erection of the first section is to be commenced as soon as the first three pontoons are launched, the compressed air machinery of the plant being used for pneumatic riveting.

Pumping Machinery

The dock will be pumped by twenty-four (24) 12-inch centrifugal pumps, one in each end of each pontoon. By referring to Fig. 2 the general arrangement and detailed construction of these pumps will be seen. The pump suction will take water from the bottom of the pontoon, the suction being protected by a liberal area of screen. Delivery will be directly through the flood gate used in lowering the dock.

The pumps will operate at approximately 275 revolutions per minute, being driven by a vertical shaft. All the pumps on each side of each section will be driven through gearing and horizontal shafting by one electric motor, as shown in Fig. 2. A jaw coupling is provided in the wing at about the level of the top of the pontoon for disconnecting the vertical shaft when the pontoon is removed for self-docking.

There will also be seen in Fig. 2 the indicator for determining the level of water in the wings. This consists of a counterweighted float in vertical guides and a vertical rod extending through the deck of the wing. As the water enters the wing the float rises, and the height of the rod above the deck will indicate the depth of the water in the wings.

A similar device, not shown, is provided to show the depth of the water in the pontoon. The flood gates are operated to control the lowering of the dock and also to control the pumping collectively and individually of the different pumps, it being understood that with the pumps running no water will be delivered if the flood gates are entirely closed, and that, by a regulation of the gates without altering the speed of the pumps, any degree of control or any distribution of control can be accomplished. In case one side is rising too rapidly the partial closing of the gate on that side, without disturbing the operation of the machinery, will affect the control, or the gates may be left at the same opening and the machinery stopped.

By this method a much quicker and more powerful control may be obtained, as not only will the discharge of water from the dock stop, but will immediately commence to enter, thus doubling the power of control which would be obtained by closing the gates.

Electrical Equipment

As previously explained, the group of pumps on each side of each section of the dock will be operated through horizontal and vertical shafting by one electric motor. Thus for the two smaller sections of three pontoons each there will be required four 100-horsepower motors, and for the larger section of six pontoons there will be required two 200-horsepower motors. The motors are to be alternating-current, three-phase, 25-cycle, 550-volt, and will operate at approximately 500 revolutions per minute. They are to have wound rotors and slip rings for variable speed control. The armature shaft is to be extended on both ends, and will operate the distribution shafts through reduction gearing at a speed of approximately 275 revolutions per minute.

There will be two motors on each section, one on each wing.

The power circuit on the pier is connected to the power circuits on the sections by flexible cables. The power circuits of each section are independent from the main circuit, so that each section receives its power independently, but the control system is to be so arranged that the two motors on any section may be operated from one master panel or the combination of any two sections may be operated from the master panel on either of the two sections, and, lastly, when all three sections are used together all six motors are to be controlled from the master panel on the middle or larger section.

and on one side of each section there will be provided an electrically-driven air compressor having a capacity of 500 cubic feet per minute. The air will be delivered to a receiver in the wing below, and from this to air piping carried along the bottom to each side of the wing, with multiple outlets for the connection of air hose to the pneumatic tools. Provision will also be made for connection between the sections of the dock when they are operating together.

Electric current for operating the air compressors will be taken from the circuits supplying the motors for pumping the

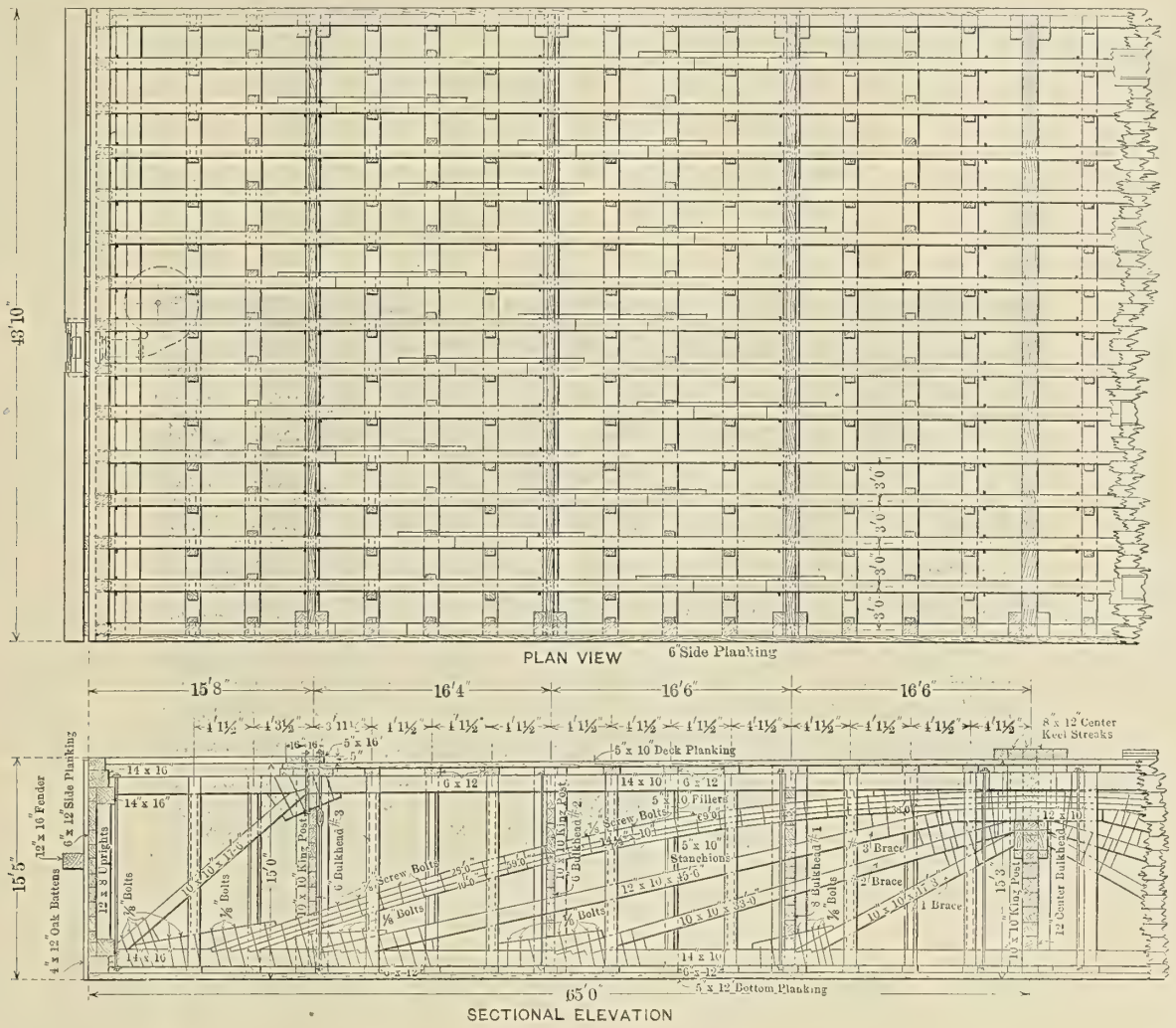


FIG. 3.—HALF PLAN AND SECTION OF FLOATING PONTOON

Master Panel

The master panel is to consist of a panel or drum having suitable contacts or switches for independently starting or stopping any of the motors. The starting or stopping of any one motor or a number of motors will not affect other motors at rest or in operation. The provision is also to be made for operating any or all motors at one-half, three-quarters and full speed.

Compressed Air Equipment

While steam-driven air compressors are provided in the power plant to furnish compressed air for the shops, it was deemed advisable on account of difficulty due to the extreme rise and fall of tide, to make flexible air connections to the floating dry dock and to provide an electrically-driven air compressor upon each section.

Machinery houses are provided for the different sections, dock, and as air will be used only after the dock is pumped up the capacity of these circuits will be more than ample.

Operating Equipment, Bilge Blocks, Keel Blocks, Etc.

Referring to Fig. 1, there will be seen the arrangement of keel blocks and bilge blocks. The keel blocks are to be of oak, 12 by 16 inches by 4 feet long, and are to have a height of 4 feet. The bilge blocks are to be on about 12-foot centers and operated according to the usual American practice by means of a galvanized chain on the floor of the dock and a leading rope through 6-inch sheaves secured to the wing near the deck, leading up and returning over the pipe railing around the tops of the wings. The return rope leads to the tail dog, and is used in tripping the dog and pulling the block out when the ship is leaving the dock. The bilge blocks are provided with an elevating screw, which has been found to be of great service for removing blocks one at a time for painting.

Steam Turbines for Auxiliary Purposes on Board Ship

BY ERNEST N. JANSON

Steam turbines of various descriptions and types are becoming more and more the choice as motors for driving auxiliary machinery on board ship. While this applies in a general way to modern steamships of the mercantile marine class, it applies particularly, and almost without exception, to naval vessels. But although the service of the steam turbine is continually making inroads on the fields only a few years ago independently held by the reciprocating engine, its application is yet restricted principally to such auxiliaries in connection with which its utility is commercially and technically expedient.

ADVANTAGES

Some of the advantages recognized to pertain to turbine propulsion will be observed to apply also to auxiliary turbine drives. Among those standing out most prominently with respect to the turbine, however, as an auxiliary are:

1. Good steam economy at designed loads.
2. Economy in floor space and lightness in weight.
3. Moderate initial cost and maintenance, no waste of oil or renewal of packing.
4. Adaptability for erection in both horizontal and vertical positions.
5. Reliability at high rotative speeds with inappreciable vibration.
6. Sealed enclosures of operating parts and automatic forced lubrication.
7. Simplicity in construction, easy attendance and few adjustments.
8. No oil used on parts coming in contact with steam, therefore no contamination of the feed-water.
9. Cleanliness in the absence of lubricating oil.

APPLICATIONS

As stated before the employment of the steam turbine for the operation of auxiliary machinery now constitutes an important detail in machinery installations on board ship. Its application is, however, limited, owing to certain circumstances prevailing on board ship, such as do not apply when used in stationary plants. The nature of these facts will be readily understood by the references which follow later.

Principal applications found for steam turbines driving auxiliary machinery on board ship are:

1. Electric generating sets.
2. Forced draft blowers.
3. Special types of rotary air pumps.
4. Centrifugal pumps.
5. Air compressors.
6. Torpedo-driving mechanism.

The most important, and by far the most extensive, is the application found under heading 1. All modern steamers, whether for river, lake, sound or ocean, together with all vessels for naval purposes of all descriptions, steamers in the lighthouse service, Fish Commission, Coast and Geodetic Survey, and a large part of those coming under the quartermaster of the War Department, are now equipped with an electric light and power plant.

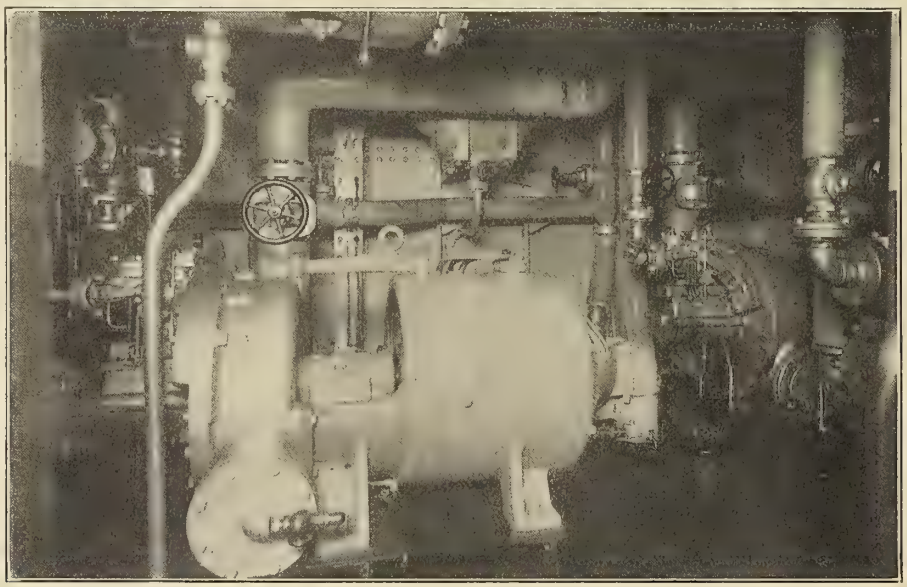


FIG. 1.—CURTIS TURBINE LIGHTING SET INSTALLED ON THE ALABAMA

The electric plant, however, is not only for the purpose of furnishing light to the various rooms and compartments, but also for the generation of current to supply adequately a number of different motors used throughout the ship. Such motors are used for driving ventilating fans, ammunition hoists, pumps, turret machinery, elevators, winches, cranes and tools. In consequence of the very extensive use for electricity on board ship electric plants have grown correspondingly large, and both the number and size of turbines for their operation have increased accordingly.

Although forced draft blowers when used in boiler installations are yet, generally speaking, in the majority of cases, driven by reciprocating engines of special design, and in quite a number of instances by electric motors, the direct-turbine drive, in special arrangements, such, for instance, as exist in torpedo boat destroyers, have particular advantages, and therefore invariably call for this combination. In this class of ships the necessity has fostered the advantage, and

lies in the fact that the blower, placed on the underside of the deck, connects directly with the ventilating cowl. As this is a place rather inconvenient of access, and therefore eliminates the use of machinery requiring much attention and frequent adjustment, as well as one where the temperature may rise to a degree where the successful operation of electric motors would be very questionable, the application of a small size, fairly economical, turbine becomes desirable for several reasons. In this connection, and as one of the reasons, the question of diameter of fan impeller, and thus of casing and space occupied, plays an important part in installations of this kind. The high pressures, of from 5 to 6 inches, required on the full-speed trials of this class of boats, call for high peripheral speed of impeller. This may be obtained either by a small diameter and high number of revolutions, which is suitable to the turbine, or by large diameter with comparatively slow revolutions, such as are characteristic of reciprocating engines.

While the steam turbine has particular merit when used in conjunction with the two foregoing auxiliaries, its utility has also become very marked as a drive in connection with rotary air pumps and air compressors. Turbo-circulating and feed pumps are also used, but less frequently than in the cases previously referred to.

Economic Considerations

As is well known, the principal items in the operation of a steam turbine, which directly influence the steam economy or the steam weight used per brake-horsepower per hour, are the speed of the vanes and the degree of expansion of the steam. Running at the speed of revolutions, which insures the proper vane speed for maximum economy, together with a wide range of steam expansion, are the ideal conditions under which the steam turbine may be operated. This condition is, however, only rarely met with when operating ship auxiliaries on board naval vessels, but invariably in ships of the merchant class, which, unlike the naval vessel, run the greater part of the time at full speed. When running at much reduced speed not only the main engine power is curtailed, but the output of blowers and pumps is correspondingly reduced by cutting down the speed of revolutions of the turbine. By so doing a very material loss of steam economy, as compared with designed (full) speed runs, ensues. The turbine-driven electric unit differs in this essential respect very materially. The "load-water rate curve," which is a characteristic of steam consumption at varying loads, is rather flat even within such limits as from one-half load up to 50 percent overload, depending largely upon the fact that said variation may be obtained with practically constant revolutions, steam pressure and vacuum. The quantity of steam admitted is regulated by governing devices, and corresponds to any electric resistance demanded by conditions of operation. In this respect the turbine drive is superior to that of the reciprocating engine, and due to considerable flexibility with respect to overload, its usefulness is materially increased.

The average steam economy of the small-power turbine, direct connected, is between 30 and 70 pounds running non-condensing, with horsepower and revolutions varying. Geared turbines show superior economy.

The usual arrangement of exhaust from turbine blowers or pumps is such that this exhaust is used for heating the feed-water, and therefore allowed to issue against a comparatively high-pressure, ranging from atmospheric to about 10 pounds gage. From this cause alone a very high steam consumption will be shown; but, purposely, so to speak, arranged for in order to obtain a high-temperature heating agent in the feed heater. The foregoing, however, does not include turbines driving the generators, as they usually exhaust into their own condensers, in which are maintained a vacuum varying from 25 to 27 inches.

Types of Turbines

Among the turbines most commonly used for auxiliary purposes, both here and abroad, we note the following well-known makes: Parsons, De Laval, Curtis, Schulz, Rateau, Terry, Elektra, Sturtevant, Kerr and others. Some of the foregoing types are constructionally adapted only when in large units of above 500 or 600 horsepower, and as such are used in auxiliary plants aboard ship for the generation of electric power of great magnitude. We find such installations in the *Lusitania*, with four 375 kilowatts, 1,200 revolutions per minute Parsons turbo-generating sets, and in the *Mauretania* with a similar installation. The new White Star Line steamers *Olympia* and *Titanic*, on the contrary, have each four independent reciprocating engine-driven electric units of about 580 horsepower each, 325 revolutions per minute.

Curtis Turbine

As is well known this type of turbine is of the pure impulse type. The principle of operation consists essentially in steam velocity being imparted to the steam by expansion in suitable

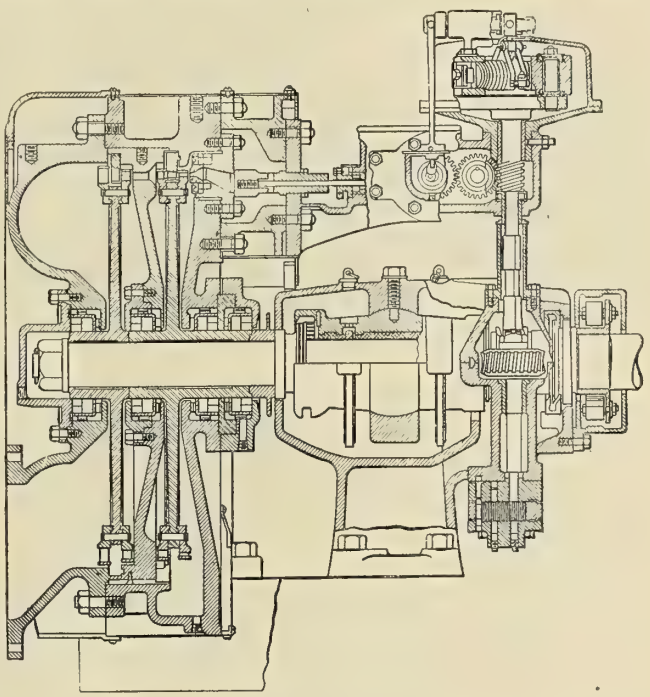


FIG. 2.—SECTION OF TWO-STAGE, NON-CONDENSING CURTIS TURBINE, 160 HORSEPOWER

nozzles. After leaving the nozzles the steam jets pass successively through two or more rows of vanes on the rotor, being deflected alternately by reversed vanes on the stationary element. The kinetic energy in the steam is thus fractionally abstracted and given up to each rotating element. The number of wheels and rows of vanes are governed by the degree of expansion and peripheral velocity, which, by various conditions and mechanical expediencies, may be considered practicable.

The turbines built by the General Electric Company, of Schenectady, N. Y., and now extensively used as prime movers for driving dynamos in ship installations, are made in sizes from 5 kilowatts up to 300 kilowatts. They are made when so used with horizontal shafts and run either condensing or non-condensing, the former condition generally prevailing. The United States navy stipulate and require in sizes below 25 kilowatts satisfactory operation when exhausting against a back pressure of 20 pounds above atmosphere. Direct connection by means of solid coupling is used between the turbine and the armature of the generator, the revolutions of

the wheel varying from 5,000 for the 5-kilowatt machine to 2,400 for a 100-kilowatt and 1,500 for 300-kilowatt turbines. The steam pressure is normally about 200 pounds, and the turbines ordinarily run condensing, but must be capable of running full load with 5 pounds back pressure. The water consumption per kilowatt-hour, when running full load, varies along a range of from 55 pounds for the 5-kilowatt turbines to about 29.5 pounds for a 100-kilowatt unit, and 26.5 pounds for 300-kilowatt units at 27 inches vacuum. Generating sets of 300-kilowatt capacity are now being placed in some of the latest battleships.

With respect to design the Curtis turbine is compact, with all of its parts self-contained, and constructionally incorporates features of durability as well as reliability. The rotor wheels are perfectly balanced and are made of steel. The cylindrical wheel casing is lagged with Russia iron, and is supported on a bedplate, which is common to both turbine and generator.

The buckets are made of an extruded nickel-bronze material,

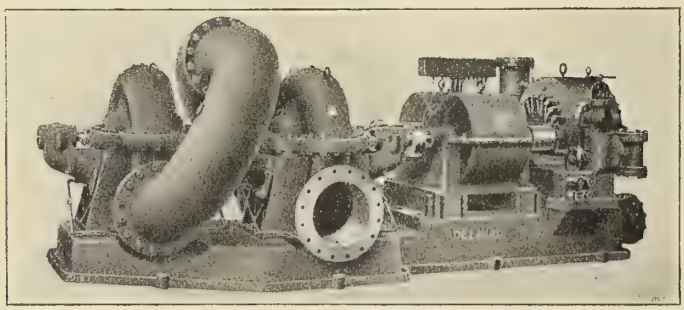


FIG. 3.—DE LAVAL TURBINE CENTRIFUGAL PUMPING SET

which is hard and tough, and has a maximum resistance to erosion and corrosion. The end of each bucket has a dovetail tenon, which fits into a groove turned in the periphery of the steel wheel disk. The wheels are keyed to the shaft, which is made in one piece.

The axial clearance between the stationary and rotating buckets is in general about .06 inch, which is ample to insure operation without friction between the revolving and stationary parts. The radial clearance may, however, be almost anything, and is usually made 1 inch or more, so as to obviate any trouble that may be caused by water accumulating in the casing. In the smaller sizes the bearings are lubricated by means of oil rings. In the larger sizes the oiling system consists of an oil pump, actuated by a worm-gear driven from the main shaft. The pressure in the system is about 10 pounds per square inch, and the oil, after having completed the circuit through the bearings, is returned to a reservoir connected to the pump suction, and is used over and over again.

In the smaller sizes a centrifugal governor is mounted on the end of the main shaft, and operates a balanced poppet valve controlling the steam admission.

In the larger sizes the centrifugal governor is driven by a secondary shaft, and controls the operation of a series of steam admission valves, which through suitable mechanism are operated from the main shaft of the turbine.

This system is practically the same as is used on large power plant turbines made by the General Electric Company. Beside the governor there is an emergency stop valve to prevent undue acceleration in case of a sudden release of the load.

In comparison with engine-driven generating sets the turbo-generators are slightly lighter in weight and take up less room both in height and width, but are longer. They have also a somewhat higher water rate.

A small size turbine of the Curtis type is now being made for driving forced draft blowers by the Fore River Shipbuilding Company. This turbine consists of one 24-inch wheel with five rows of movable buckets and four intermediary ones. It is quite compact, and is being built for use on the new torpedo boat destroyer *Henley*. It is connected direct to the fan impeller, and runs at about 1,400 revolutions per minute.

Parsons Turbine

This type of turbine being inherently unsuitable for small power units has not as yet become of general utility for auxiliary purposes on board ship. As has been already mentioned in this article the generating sets of the Cunard steamers *Lusitania* and *Mauretania* are operated by Parsons turbines. Each one of said turbines is about 525 horsepower and runs at 1,200 revolutions per minute. Their general design is in most of the details similar to turbines built for and operating plants for stationary purposes. But as it is not possible on board ship to obtain the same substantial foundation as on land, a feature of special interest appears in the fastening down of the turbines. To minimize as much as possible the sound which otherwise may be transmitted throughout the ship through the steel decks a rubber insulation is placed directly under the turbine bedplate, a heavy wood filling being placed between the rubber and the deck. Rubber washers, together with rubber bushings in the holes of the bedplate for the holding-down bolts, are everywhere placed in position.

On economy tests performed with these turbines the water consumption at half load was on an average of 61 pounds per kilowatt-hour; at three-quarters load the consumption was 52.5 pounds, and at full load 47 pounds on an average, the back pressure in each case being about 5 pounds, while the steam pressure was 160 pounds gage. The turbines were designed to give full load when exhausting into a back pressure of 10 pounds.

De Laval Turbine

The De Laval type, together with Parsons, constitutes the pioneer types of turbines. It was introduced here as early as 1896, and is being manufactured in units to meet any commercial demand by the De Laval Steam Turbine Company, Trenton, N. J.

De Laval steam turbines are classified under four types:

Class A. In which the steam is expanded completely in one set of nozzles. The velocity of the jet, attained by expansion of the steam in the nozzles, impinges against a single row of buckets, which are attached to a single wheel. As a result of the very high velocity of the steam jets issuing from the nozzles the buckets must also have a very high speed, which is equivalent to a high number of revolutions. In order to make the speed of the driven machine, such as dynamo or pump, come within the practical limits allowed for such machines, a helical pinion and double gear is introduced as a means of speed reduction.

Class B. Is in every respect the same as Class A, with the exception that no gearing is used. This makes an extremely simple and fairly efficient prime mover, which is used in connection with machines that may be run at a very high speed of revolution. Such machines are centrifugal air compressors, small alternators, blowers and certain pumps.

Class C. The steam in this type is expanded in the same manner as in the two types previously mentioned, but instead of one row of moving buckets there are two rows mounted upon a single wheel, with one row of stationary guide vanes between. A modification of this type, Class D, is one in which the steam is expanded in successive sets of nozzles with a corresponding number of pressure stages, each containing revolving discs, with the buckets, in single or double rows, attached. The driver-machine may be directly connected or driven by means of a gear, according to speed requirements.

The De Laval type "C" turbine, as adapted for driving

centrifugal boiler feed and ballast pumps, dynamos and fans and blowers on shipboard, will be more fully discussed in a future issue.

In the construction and design of the De Laval type of turbine we note the following essential parts:

The nozzle is a conically shaped tube, designed both for high-pressure condensing service and low-pressure condensing or high-pressure non-condensing service. Each turbine is fitted with several nozzles, which can be independently operated by individual closing valves, and their number in service at one time may be regulated according to the load.

The buckets are drop-forged, with surfaces coming in contact with the steam, smooth finished with sharp edges and with the proper thickness. Lugs are found upon the outer ends of each bucket, touching the bucket in front to form a continuous band over the ends. The shank is finished with a bulb, which fits in radial slots milled in the edge of the turbine wheel. The buckets are assembled in the wheel when heated, and are tightly held by contraction upon cooling.

The wheel is made of forged steel, and is so designed as to be of uniform strength. A groove is turned just beneath the point of attachment of the buckets, forming a section of least strength, and in case of excessive speed will break the rim at this point, whereby the buckets will be thrown off before other damage is done.

The shaft is flexible and of suitable diameters. With a flexible shaft suitably proportioned the wheel, when a certain speed is reached, rotates about its true mass-axis instead of its geometrical center, and thus obviates vibration.

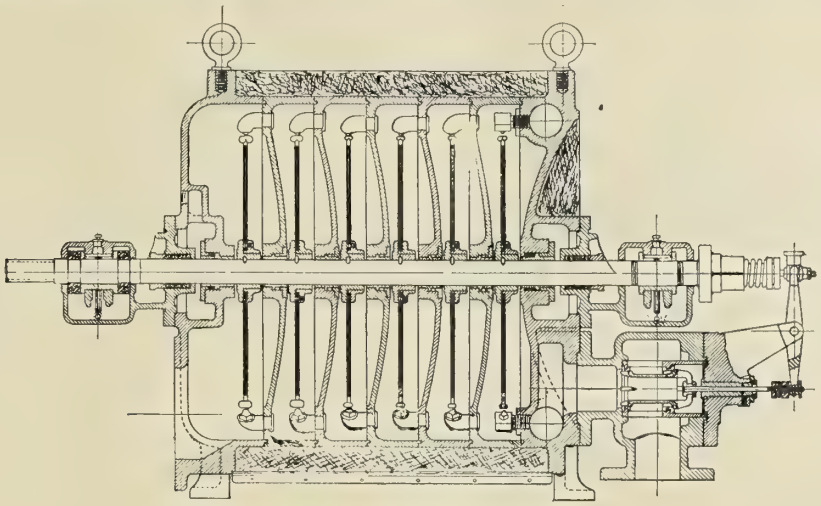


FIG. 4.—SECTIONAL VIEW OF KERR TURBINE

The bearings are three in number, the first of which is just outside the wheel case, held in a bracket and has a spherical seat. The other two are close to the pinion, one on each side. They are made of bronze with special babbit, having lubricating grooves.

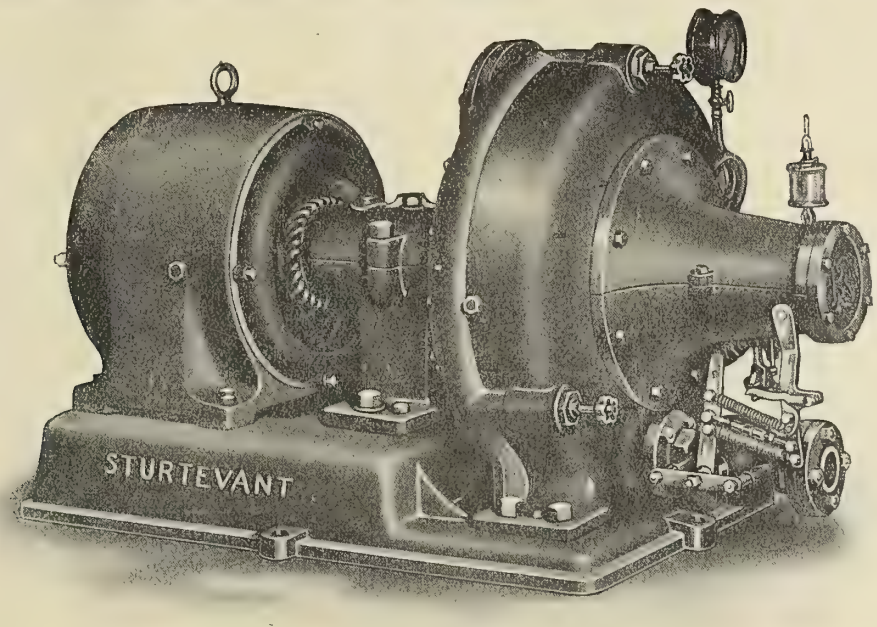


FIG. 5.—STURTEVANT TURBINE-DRIVEN LIGHTING SET

The packing bushings are formed of two small sleeves made of babbit and lined with graphite, which forms a film between the shaft and the bushing that effectually prevents leakage. It is very important in all condensing turbines to prevent air leaking into the wheel and thus insure a good vacuum. No lubrication is required in a graphite bushing.

The gears have for their purpose to reduce the speed of the turbine shaft to a speed suitable to the driving shaft. They

are of the herring bone or helical type, and are machine cut of a fine pitch, so that a large number of teeth may be in contact at one time. The pinion is made of high-grade steel, while the drum of the gear is made of cast iron with a seamless ring forced on.

It may be incidentally mentioned that the gears now used in the propulsion of ships in connection with multi-stage turbines are in all essential respects identical with those used in the De Laval turbine.

The governing mechanism is of a simple and substantial design, and consists of two weights hinged on knife edges,

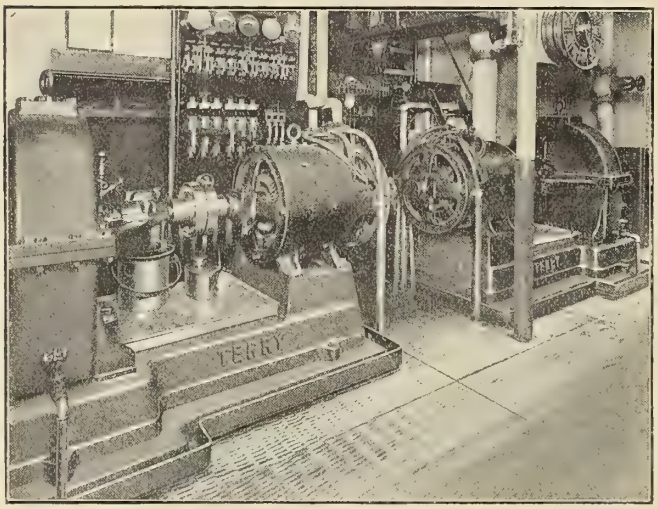


FIG. 6.—30-KILOWATT, 120-VOLT TERRY TURBO-GENERATING SETS IN THE ENGINE ROOM OF THE CITY OF BALTIMORE

which weights, when subjected to the centrifugal force, move outward, and by means of a spring and bell crank operate the throttle valve, through which steam is admitted to the steam chest of the turbine.

Kerr Turbine

This type of turbine, although of a much more recent design and manufacture than any of those previously referred

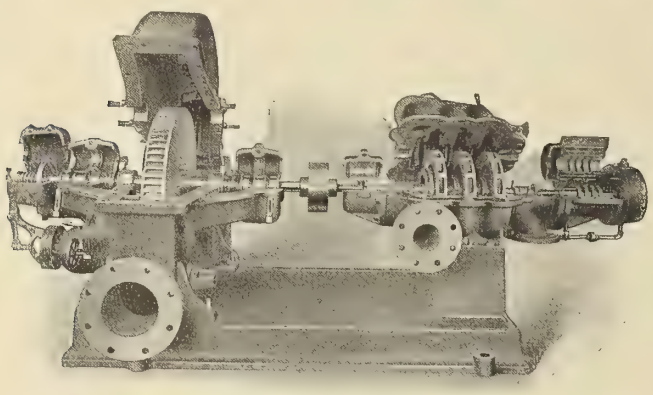


FIG. 7.—THREE-STAGE, 400-GALLON BOILER FEED PUMP DRIVEN BY TERRY TURBINE ON BOARD THE S.S. SIERRA

to, has found an extensive field of application for various installations.

It is of the pure impulse type, and belongs to the class commonly termed "multi-stage turbines," and is made in all sizes from 5 to 600 horsepower. It is manufactured by the Kerr Turbine Company, Wellsville, N. Y., and is being built with from two to eight stages, each stage having its own set of nozzles and disks. As in all impulse turbines its operation rests in the fact of steam attaining a high velocity when expanding in suitably-formed nozzles, and in the jet energy being absorbed by buckets attached to revolving disks. Having a number of stages the pressure drop at each stage becomes comparatively small, and the jet velocity, being also determined by the expansion of the nozzles, may be kept down to reasonable figures and the revolutions of the shaft proportionately. The general arrangement of each wheel and action of impulse upon the buckets resemble those in a Pelton water-wheel.

The turbine cylinder is of cast iron, divided by diaphragms into as many stages as may be desired. Each stage contains one rotor wheel, to the periphery of which the buckets are attached. The wheels are made of flange steel and are attached to the shaft.

The nozzles are located around the inner periphery of the cylinder, with orifices pointing towards the face of the buckets. The number and dimensions are determined by consideration of power and speed, and for multi-stage turbines are so proportioned in the various stages that a uniform velocity is obtained throughout. The nozzles, and the holders for the nozzles, are made of cold-rolled steel, the former being screwed into the latter, which are fastened in the diaphragms.

A new construction, known as "Type M," has now been used in a number of Kerr turbines, in which the nozzles and buckets are supplanted by vanes and blades, thus giving a parallel flow. Ten percent better steam consumption with non-condensing and 15 percent with condensing is guaranteed by the manufacturer for the new construction as compared with the old.

The buckets are made of drop-forgings. There is a throttling governor, actuated by centrifugal force, as well as an emergency governor. In generator work, or where very close regulation is desired, a governor of the oil relay type is used.

Besides the regular bearings there is a thrust-bearing to insure a definite position of the wheel with reference to the nozzles. A special type of this turbine is used for driving the forced draft fans on three torpedo boat destroyers of the United States navy. These turbines are direct connected, and under maximum conditions run at about 1,530 revolutions per minute, the fans maintaining then about 3.3 inches of water pressure. Used in this connection the turbine shaft is vertical, and there are seven stages. The total outside diameter does not exceed 24 inches, and the total length from the fan cone is about 48 inches. A step-bearing made of shouldered steel discs hold the rotor in position.

Terry Turbine

The Terry turbine, built by the Terry Steam Turbine Company, of Hartford, Conn., has been in commercial use for five or six years. It is of the pure impulse type, and for non-condensing work has only one expansion stage, the steam being expanded in correctly proportioned jets down to terminal pressure. For condensing work the machines are designed with one, two or three stages, according to operating conditions and speed. The principle of action is essentially that of any other impulse turbine, all the expansion taking place in the stationary nozzles and the heat energy of expansion being converted into kinetic energy. The steam on leaving the nozzles enters one side of the semi-circular buckets, and is reversed through 180 degrees, and enters a stationary member called the "reversing chamber," which is also semi-circular in form, and returns the steam into the same wheel parallel to the original stream. This cycle is repeated as often as necessary to absorb all the velocity energy in the steam. In the case of two or more stage machines partial expansion only takes place in each stage; for instance, in a straight condensing proposition expanding from 150 pounds to 27 inches vacuum the pressure at the outlet of the high-pressure nozzles will be about atmospheric pressure.

In all essential features, such as automatic lubrication of bearings, emergency spring loaded valves, shaft glands, etc., these are, of course, found here as in all other turbines. This company, however, build practically all of their governors directly mounted on the turbine shaft and run at turbine speed. The cases in all their machines are divided along the center line of the shaft.

The Terry turbine has been used quite extensively for the driving of forced draft sets on torpedo boat destroyers. A special design is employed for this work, as the turbines must be vertical. As in the horizontal machines, the case is divided along the center line of the shaft and the cover hinged to allow easy access to the rotating member.

The step bearing employed is ball-bearing type, placed at the lower end of the shaft, and a gear oil pump is fitted for supplying oil to the different bearings.

Sturtevant Turbine

The Sturtevant turbine is of the compound-impulse, single-wheel type, and may be made in sizes of from 3 horsepower up to 300 horsepower. So far as known only turbines of sizes suitable for driving forced-draft fans have up to the present been built for ship installations. Thus it is intended to replace the reciprocating engine blowers on the United States ships *Smith* and *Lamson* with turbo-blowers of this type.

The Elektra Turbine

Like all of the turbines described, and, in fact, nearly all small-power turbines, this is also of the impulse type. The steam enters a passage surrounding the casing and communicates with a number of expanding nozzles. The divergence of the nozzles is such as to give minimum pressure fall, and therefore velocity. With the several nozzles or return chambers through which the steam flows upon its successive course through the wheel, nearly all of the velocity and consequently the energy is abstracted from the steam.

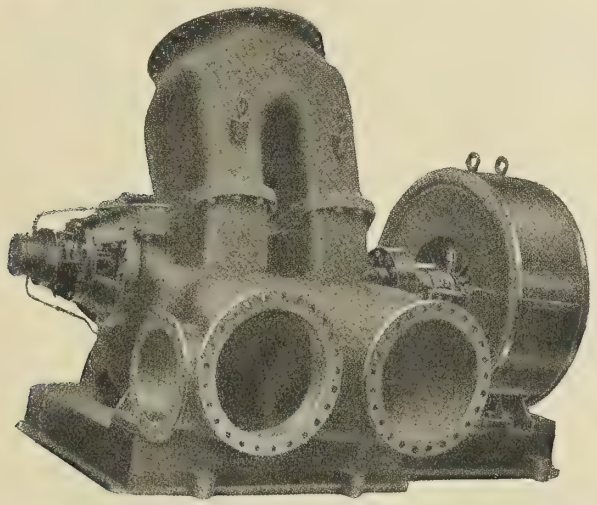


FIG. 8.—CENTRIFUGAL CIRCULATING PUMPING SET DRIVEN BY TERRY TURBINES FOR THE U. S. BATTLESHIP ARKANSAS

Installations

The following contains the essential requirements of the specifications pertaining to turbines when driving electric generating sets and forced-draft blowers for installations in naval vessels:

Turbo-Generators.—The turbines must be perfectly balanced and of high efficiency and economy. They must be provided with an approved oiling arrangement and have automatic regulation for speed governing. Their operation must be noiseless, without undue heating at maximum load, and must be able to stand any sudden change of load without injury to any of their parts.

They must be capable of running continuously at full load with a vacuum, or when exhausting against 5 pounds back pressure. Also to operate satisfactorily at pressures 20 percent above or below the normal of 200 pounds pressure. When, however, running below and against 5 pounds of back pressure only 90 percent of full load need be developed.

Turbo-Blowers.—Having reference to torpedo boat destroyers, the motive power for forced-draft blowers shall be

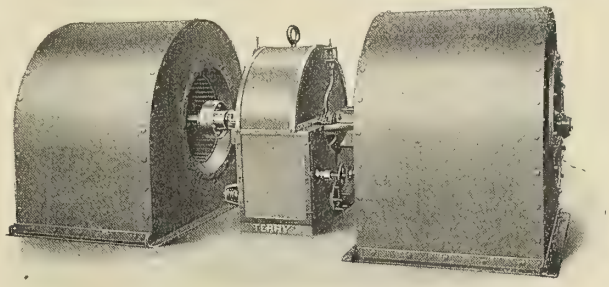


FIG. 9.—MERCHANT SERVICE TYPE OF MARINE FORCED-DRAFT TERRY TURBINE-DRIVEN UNIT. CAPACITY, 25,000 CUBIC FEET PER MINUTE

steam turbines. The speed of revolutions should be about 1,400 per minute at full speed and power, and must be designed to develop the rated output when exhausting against 10 pounds pressure.

A governor must be placed in the steam connection, and be arranged to operate a quick-closing valve to shut off steam in case of undue overspeed. The working parts must be enclosed and proof against dust, yet readily accessible for overhauling. Automatic oiling arrangements must be furnished all bearings, and means must be provided for the attachment of portable revolution counters. It is further stipulated that suitable gear must be arranged for operating the turbine, both from the compartment in which placed and the deck immediately above.

Actual Installations.—All of the types of turbines previously described are installed for auxiliary purposes for one purpose or other in different classes of ships. Thus we find the De Laval turbine used for driving forced-draft blowers in several large steamers belonging to the French transcontinental lines, and also for distiller circulating pumps.

Previous to this time turbo-generating sets had not been tried in the navy, but were then beginning to be installed on a large scale. In the United States ship *New Hampshire*, contracted for in 1904 and delivered in 1908, the forward dynamo room was fitted with a complete turbo-electric outfit, consisting of two direct-current generating sets, driven by horizontal Curtis three-stage, direct-connected turbines, with, respectively, three and two rotating rows of vanes in the first, second and third stage, the revolutions being about 1,700 per minute.

This installation seemed the connecting link in the stage of transition between engine and turbine drives. Practically every ship since then has been fitted with turbine drives for electric power generation aboard naval vessels.

The Curtis type turbine, as made by the General Electric Company, of Schenectady, N. Y., has been fitted to the following naval vessels:

New Hampshire, two 100-kilowatt generating sets.
South Carolina, four 200-kilowatt generating sets.
North Dakota, four 300-kilowatt generating sets.
Delaware, four 300-kilowatt generating sets.
Florida, four 300-kilowatt generating sets.
Utah, four 300-kilowatt generating sets.
Arkansas, four 300-kilowatt generating sets.
Wyoming, four 300-kilowatt generating sets.

Cincinnati, two 30-kilowatt sets.
Raleigh, two 30-kilowatt sets.
Iowa, three 100-kilowatt sets.
Michigan, four 200-kilowatt sets.

All of foregoing 300-kilowatt machines have two stages, three rows of moving buckets with revolutions of 1,500 per minute.

Among ships fitted with the same type of turbine, but of

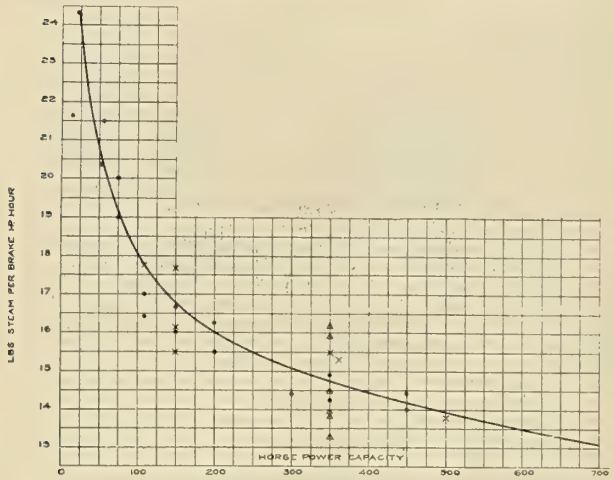


FIG. 10.—DIAGRAM SHOWING VARIATION OF STEAM CONSUMPTION OF DE LAVAL TURBINES, WITH CAPACITY

only 5-kilowatt capacity, being of the single-stage, four-nozzle horizontal type, direct connected, 5,000 revolutions per minute, we find something like twenty-five torpedo boat destroyers. In merchant vessels the installation of two 35-kilowatt, 3,500 revolutions per minute sets on the steamship *Alabama* for the Goodrich Transit Company, Chicago, Ill., may be cited as an example. Curtis turbines for lighting sets are installed in sizes of from one 75-kilowatt set to three 35-kilowatt sets on seven United States transports; the United Fruit Company has twelve steamers with four 35-kilowatt sets each; the Merchants & Miners' Transportation Company three steamers with one 35-kilowatt set, and two Standard Oil steamers and one collier have installed 10-kilowatt sets.

Terry turbines are used extensively in marine service. On

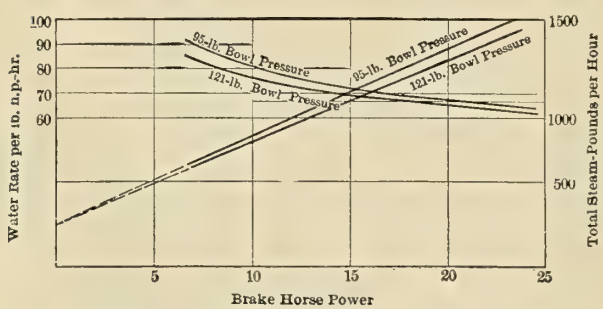


FIG. 11.—STEAM CONSUMPTION CURVES, STURTEVANT TURBINE, 20-INCH WHEEL, SINGLE-STAGE, NON-CONDENSING, 2,400 R. P. M.

merchant craft they are largely used for boiler-feed service, ballast pumps, lighting and forced draft.

On United States Government vessels alone 140 Terry turbines are being used or installed as follows:

Generators—On battleships, destroyers and other boats,, twenty-eight 5 to 100-kilowatt sets.

Blowers—On destroyers, 104 forced draft sets; other boats, four forced draft sets.

Pumps—On battleships and other boats, four 17 to 400-horsepower pump sets.

Terry turbines are also being used in the British and Chinese navies.

The latest application of the Terry turbine is for driving condenser circulating pumps on the *Arkansas,* illustration of which is given.

Kerr turbines are used in a similar way for operating the blowers on United States ships *Perkins, Sterrett* and *Walke.*

A type of the Elektra turbine, which is extensively used for stationary purposes in European practice, has had a practical test in this country as a ship auxiliary in connection with the Leblanc air pump installed on the United States collier

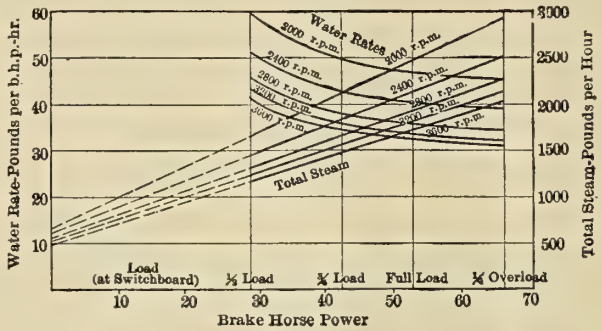


FIG. 12.—STEAM CONSUMPTION CURVES, 200-H.P. CURTIS TURBINE, THREE-STAGE, 36-INCH WHEEL, NO SUPERHEAT, NON-CONDENSING

Neptune, built by the Maryland Steel Company at their marine plant in Sparrows Point, Md. The air pumps were built by the Westinghouse Machine Company, Pittsburg, Pa., and when tested in the shops ran about 2,200 revolutions per minute, developing about 50 horsepower on an average steam consumption of 50 pounds per horsepower, exhausting at 10 pounds pressure.

What may be considered a disadvantage with turbine installations when used for electric drives on board ship is the increased vacuum necessary in order to obtain satisfactory steam economy. The much augmented steam volume with a 27-inch vacuum common with turbine drives over 16 or 20 inches, as were customary with engines, requires very much larger exhaust pipes. The space occupied by these pipes in the often rather cramped spaces allotted to them in the ship arrangement often leads to difficulties. Moreover, the whole

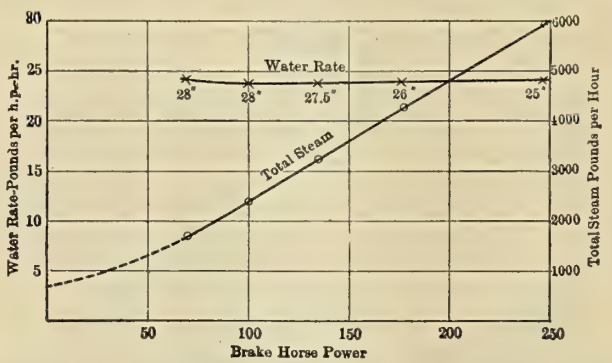


FIG. 13.—STEAM CONSUMPTION CURVES, 24-INCH KERR TURBINE, SIX-STAGE, CONDENSING, VARYING VACUUM, 70 POUNDS PRESSURE GAGE

condensing apparatus must be larger, and as a whole becomes more expensive as well as requires more space. The turbine, together with the generator, are bolted down, and through the bedplate are fastened direct to the steel foundations without any resilient material to deaden sound or to minimize shock.

The Parsons turbine as an auxiliary aboard ship has been previously referred to.

While undoubtedly many installations have been made with various other types of turbines in connection with the furnishing of power for auxiliaries aboard ship, the application, being of comparatively recent origin, precludes in many instances the necessary data for the diffusion of reliable information.

Steam Economy

Only an approximation to actual steam economy can be given here, as the numerous circumstances inductive of results cannot possibly be accounted for. Two distinct conditions which substantially influence the steam economy must, however, be carefully noted, viz.: running, condensing and running non-condensing, or, in other words, with a vacuum or with atmospheric or higher pressure at the exhaust. Other items which influence the economy in a very material degree are running at designed power, below or above at an overload. Also running at rated number of revolutions, or at speed much below.

The following give some actual test data or guaranteed economies:

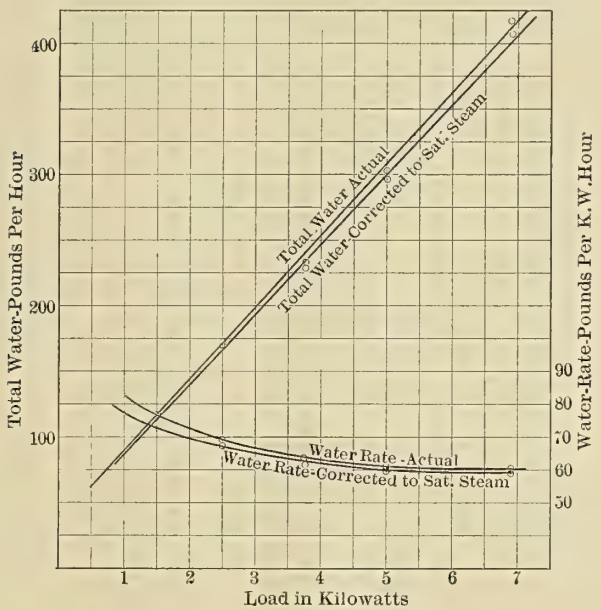


FIG. 14.—TESTS OF 5-K.W. TERRY TURBO-GENERATING SET ON U. S. S. FANNING. STEAM 187 POUNDS, VACUUM 27 INCHES, SPEED 3,820 R.P.M.

TESTS OF 5-K. W. TURBO-GENERATING SET FOR U. S. S. T. B. D. FANNING.

Built by the Terry Steam Turbine Co., Hartford, Conn.

	Guaranteed.	Results of Test.
Date of test	.....	8/8, 9, 12/11
Steam pressure	200.	187.6
Quality	1.00	.982
Vacuum, inches	25–28	27.
Speed, R. P. M.	3800.	3820.
33⅓% overload water-rate, steam 186.6, vacuum 26.7, quality .982	.....	60.4
33⅓% overload water-rate, corresponding to saturated steam at 200 pounds	78.	58.5
Full load water-rate, steam 187.6, vacuum 26.87, quality .9825	.....	60.6
Full load water-rate, corresponding to saturated steam at 200 pounds	62.	58.8
¾ load water rate, steam 187.2, vacuum 27.00, quality .983	.....	62.4
¾ load water-rate, corresponding to saturated steam at 200 pounds	71.	60.6
½ load water-rate, steam 187.4, vacuum 27.1, quality .983	.....	68.43
½ load water-rate, corresponding to saturated steam at 200 pounds	81.	66.35
Maximum momentary speed variation, load thrown off	.....	2.11%
Settled speed variation, normal condition	3.50%	.79%
Maximum jump volts, load thrown off	18.75	5.6
Maximum temperature rise, full load	40.	31.
Maximum temperature rise, 33⅓% overload	60.	41.
Volts variation, compounding test	2.5	2.4
Over-speed trip, in % above normal	10.0	5.94
Commutation after full load	.....	No. 1
Commutation after 33⅓% overload	.....	No. 1¼

Operation satisfactory with 33⅓% overload and 5 pounds back pressure. All water rates in pounds per K. W. hour. (Normal steam.)

Terry Turbines.—For generators, by test, full-load capacity of generator, 85 kilowatts.

Steam pressure = 150 pounds.
Quality steam = 1.00.
Vacuum = 27 inches.
Revolutions per minute, 2,300.
Water rate, full load per kilowatt-hour, 32 pounds.
Water rate, half load per kilowatt-hour, 43 pounds.
Water rate for forced draft blowers, by test.

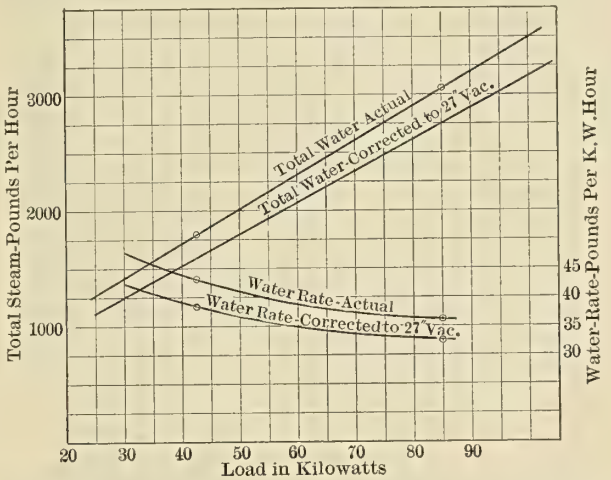


FIG. 15.—TESTS OF 35-K.W. TERRY TURBO-GENERATING SET ON U. S. S. YOSEMITE. STEAM 150 POUNDS, VACUUM 27 INCHES, SPEED 2,240 R.P.M.

Steam pressure, 160 pounds.
Back pressure, 20 pounds absolute.
Revolutions per minute, 1,400.
Brake horsepower, 60.
Water rate per brake-horsepower-hour, 1,400 revolutions, 59 pounds.
Water rate per brake-horsepower-hour, 1,000 revolutions, 77 pounds.

For further information the reader is referred to economy curves shown in Figs. 10-15.

In conclusion it may be added that the small-type turbines, while not as economical under slow speed conditions of operation as the best engines, on the whole are to be preferred for the different advantages they offer when used for auxiliary purposes.

Boiler Manufacturers' Convention

The twenty-fourth annual convention of the American Boiler Manufacturers' Association, together with its associate members and the Supplymen's Association, will be held in New Orleans, La., March 12, 13, 14 and 15, 1912. Some very important papers will be presented at the meeting, and other important business of interest to all the boiler manufacturers in the United States and Canada and supply houses dealing with the boiler and tank industry will be transacted. An extensive programme of entertainment has been arranged, and a large attendance of boiler manufacturers and supplymen from the United States and Canada is expected. Information relative to rates, hotel accommodations, can be obtained from F. B. Slocum, Continental Iron Works, Brooklyn, N. Y.

Navy League Annual Convention

The seventh annual convention and dinner of the Navy League of the United States will be held in Washington, D. C., February 22 to 24. The convention will open at 10 A. M., February 22, at the New Willard Hotel, where the dinner will also take place the same evening.

The World's Progress in Shipbuilding in 1911

From information compiled by the *Glasgow Herald* the total tonnage of vessels, including warships, built in the world in 1911 was 50.9 percent greater than that built in 1910. In the United Kingdom there was an increase of 55.3 percent, in Germany 84.6 percent, in France 84.9 percent, in Holland 44 percent, in Italy 141 percent, and in Japan 40.3 percent. The greatest increase occurred in Russia, although the total tonnage was comparatively small. This remarkable increase simply indicates the beginning of a new warship building programme, which heretofore the shipbuilding industry in that country has lacked. In only one of the leading shipbuilding countries was there a decrease over the past year, and that was in the United States, where the total tonnage built in 1911 was 23.6 percent less than that built in 1910. This decrease was due entirely to the lack of work in the large shipyards on the Great Lakes, where over-production in the preceding year reduced the demand for new tonnage in 1911.

The figures are as follows:

	1911.		1910.		Increased Tonnage Built
	Tons.	I. H. P.	Tons.	I. H. P.	Percent.
England	1,221,948	1,139,527	752,136	861,034	62.5
Scotland	671,624	837,668	420,250	624,268	60.0
Ireland	186,825	150,116	167,102	137,730	11.8
United Kingdom totals.	2,080,397	2,127,311	1,339,488	1,623,032	55.3
Colonial	29,249	12,875	24,077	10,237	21.5
Germany	401,881	666,785	217,748	306,087	84.6
United States	268,561	257,825	351,369	304,689	—23.6
France	184,411	324,205	99,796	165,630	84.9
Holland	178,618	101,730	124,115	86,019	44.0
Russia	94,905	169,215	1,854	160	5000.0
Italy	86,814	148,150	36,075	62,600	141.0
Japan	84,462	164,375	60,192	96,633	40.3
Austria-Hungary	68,390	48,485	32,121	29,706	113.0
Norway	38,222	41,004	32,998	30,890	15.9
Denmark	18,961	18,040	11,922	10,753	59.0
Belgium	12,489	1,798	15,302	26,965	—18.4
Sweden	9,734	16,931	9,733	21,940	.....
Spain	6,760	10,800	3,234	.....	109.0
China	4,222	3,920	5,211	3,205	—19.0
Greece	.....	.....	20	180	.....
Grand total	3,568,076	4,103,449	2,365,255	2,778,725	50.9

A comparison of the work done in the principal shipbuilding centers of the world is shown by the following table:

PRINCIPAL DISTRICTS.

	Vessels.	Tons.	I. H. P.
The Clyde	413	630,583	789,929
The Tyne	125	417,175	421,060
Germany	330	401,881	666,785
The Wear	86	286,834	193,343
Tees and Hartlepools	134	279,245	160,640
United States	160	268,561	257,825

As has been the case in the last two years, the largest tonnage launched by any one concern during the year was by Harland & Wolff, at Belfast. Nearly as large a tonnage was launched by Swan, Hunter & Wigham Richardson, and the other leading shipbuilders were all British concerns.

LEADING SHIPBUILDERS.

	Vessels.	Tons.
Harland & Wolff	10	118,209
Swan, Hunter and Wigham Richardson	24	109,861
Wm. Doxford and Sons	17	80,400
Sir W. G. Armstrong, Whitworth & Co	13	74,124
Wm. Gray & Co.	18	73,588
Russell & Co	14	72,230

The largest ship launched during the year was the White Star liner *Titanic,* sistership to the *Olympic,* at Belfast. As in the case with tonnage, the Harland & Wolff and the Swan Hunter & Wigham Richardson Companies stand at the head of the list for having launched the largest ships during the year, the former with the *Titanic* and the latter with the Cunarder *Laconia.* The *Laconia,* however, is a much smaller ship, being of only 18,150 gross tons as compared with the *Titanic's* 45,000. The next largest vessel was also launched by Harland & Wolff. It was the Royal Mail liner *Arlanza* of 15,000 tons. Other large ships launched in 1911 included the *Cap Finisterre,* 14,500 tons, by Blohm & Voss at Hamburg, Germany; the *Shinyo Maru,* 13,377 tons, by the Mitsu Bishi Company at Nagasaki, Japan, and the *Orama,* 12,927 tons, by John Brown & Company, at Clydebank. The *Titanic* and *Orama* have combination reciprocating and turbine machinery, the *Laconia* and *Cap Finisterre* reciprocating engines and the others Parsons turbines.

In the United States, which was the only large shipbuilding center in the world where there was a marked decrease in the tonnage built in 1911, somewhat unusual conditions existed. In recent years the greatest amount of tonnage built in the United States has come from the shipbuilding districts on the Great Lakes. The largest company there is the American Shipbuilding Company, which comprises seven yards, and which has usually figured as one of the leading shipbuilders in the world in the point of tonnage produced.

This year, however, this firm does not appear in the list of leading shipbuilders given above, and the depression there was evident in most of the shipbuilding yards on the Great Lakes. This decrease of tonnage built on the Great Lakes was responsible for the decrease in the total tonnage built in the United States during 1911, and was caused principally by the over-production of bulk freighters in the preceding year. From present indications, however, these yards will soon resume their former rate of production, as the demand for more bulk freighters will soon be felt. During the last year several freight steamers were built on the Great Lakes for ocean service, and other similar orders are now in hand. The production on the Lakes in 1911 included only five large bulk freighters, as compared with records of from twenty to forty of such vessels each year in the past five years. The number of other vessels, including passenger steamships and packet freighters, amounting to a comparatively small part of the total tonnage, was about equal to the amount of work done in previous years.

As the conditions on the Great Lakes have only a purely local effect depending upon the maritime commerce on inland waters, the records of the coastwise shipyards must be looked to for an indication of the position of the United States in relation to the world's shipping. Here we find every indication of an increase in tonnage under construction, which corresponds favorably with the rate of increase in other important shipbuilding countries. The total tonnage built in the past year was not large, but at the present time most of the larger shipyards on the Atlantic Coast are rapidly booking orders, which will fill these establishments to full capacity for several years to come. The impetus to shipbuilding comes largely from the new conditions which will result from the opening of the Panama Canal.

The largest single order which is now before the shipbuilders of the Atlantic Coast is the call for bids for four ships by the Pacific Mail Steamship Company, each of which is to be of 15,000 gross tons, 660 feet long between perpendiculars, 75 feet beam, 50 feet depth, with a load draft of 30 feet. The ships are to have a speed of 16 to 18 knots.

Another large order was recently placed by the American-Hawaiian Steamship Company with the Maryland Steel Company at Sparrows Point, Md., for five 10,000-ton passenger and freight steamers.

At the New York Shipbuilding Company, Camden, N. J., naval work predominates at the present time. There are under construction the 26,000-ton battleship *Arkansas* and the 27,000-ton battleship *Moreno*; a Chinese cruiser and two United States destroyers. As far as merchant work is concerned, three large oil tank steamships have been ordered by the Standard Oil Company, and the hull for the largest river steamer in the world, the *Washington Irving*, which will be in service on the Hudson River next summer, is under construction. Besides the five large freight steamships for the American-Hawaiian Steamship Company, there are building at the Maryland Steel Company's plant two 10,000-ton colliers for the United States navy. Some small harbor and river boats have also been delivered during the year.

As is usually the case, the Government work is fairly well distributed through the Atlantic Coast yards. At the Newport News Shipbuilding & Dry-Dock Company, Newport News, Va., the battleship *Texas*, one submarine, one destroyer, two colliers and two revenue cutters are now under construction. They also have a freight steamship of 3,500 gross tons for the Bull Steamship Company, New York, and a 6,000-ton passenger and freight steamer for the Clyde Steamship Company. At the William Cramp & Sons Ship and Engine Building Company, Philadelphia, most of the construction is naval work, including the battleship *Wyoming*, five destroyers, a submarine and two Cuban naval vessels. Similarly, at the Fore River Shipbuilding Company, Quincy, Mass., besides a large suction dredge built for the United States War Department, and some small fishing steamers, the work in hand is naval work, including the Argentine battleship *Rivadavia*, two United States destroyers and six submarines. Four destroyers are also building at the Bath Iron Works, Bath, Me.

On the Pacific Coast the tonnage, though small, is beginning to increase, indicating that the next year will be a satisfactory one. Twelve vessels, including four submarines for the United States, two submarines for the Chilean Government, and five steel whaling ships and one passenger steamer are building at the Seattle Construction & Dry-Dock Company, Seattle.

At the Union Iron Works, San Francisco, Cal., several submarines and coasting steamers are under construction, and, as in all of the Pacific Coast yards, such as the Hall Brothers, Marine Railway & Shipbuilding Company, Eagle Harbor, and the Craig Shipbuilding Company, Long Beach, Cal., a large amount of repair work has been done.

DISTRIBUTION OF SHIPBUILDING IN UNITED KINGDOM.

	1911.			1910.		
	Vessels.	Tons.	I. H. P.	Vessels.	Tons.	I. H. P.
The Clyde	413	630,583	789,929	358	392,392	593,840
The Forth	31	11,319	9,355	17	9,385	5,935
The Tay	31	17,303	14,770	15	5,982	7,800
Dee and Moray Firth	82	12,419	23,614	60	12,491	16,693
The Tyne	125	417,175	421,060	81	236,688	272,991
The Wear	86	286,834	193,343	58	173,673	124,205
Tees and Hartlepools	134	279,245	160,640	86	187,305	115,975
Mersey to Solway	128	84,085	144,449	95	41,835	144,804
The Humber	117	44,966	55,770	77	28,033	42,710
The Thames	167	38,504	72,751	143	11,532	30,680
English Channel	97	8,829	90,974	93	11,373	128,969
Bristol Channel	36	3,050	540	56	9,176	700
Royal Dockyards	7	59,260	.....	4	52,521	.....
Ireland	24	186,825	150,116	.....	167,102	137,730

All of the shipbuilding districts in the United Kingdom shared in the substantial increase in the production of tonnage for the year 1911. As usual, the Clyde shipyards surpassed the other districts in the matter of total tonnage, and the output there was all the more remarkable on account of the low records made in the last three years. The new records were made not by the construction of large ships, but by a vast increase in the construction of vessels of moderate size, principally trading steamers of from 2,000 to 9,000 tons. There was, of course, a great variety of work, including almost every type of ocean, harbor and river steamer. Some unusual ships were built, the most notable of which was the 5,000-ton oil-engined vessel *Jutlandia*.

The increase in tonnage built on the Clyde was also accompanied by a marked increase in marine engineering work. Much of this was the manufacture of turbines. At the present time the prospects on the Clyde are very good. The largest ship under way is the *Aquitania* at Clydebank. Four large steamers for the Canadian service, a New Zealand liner, and 50,000 tons of P. & O. steamers are also on the stocks in various yards. Besides the oil-engined vessel already mentioned, the Clyde Shipbuilding Company of Port Glasgow is building another oil-engined ship for service on the American lakes.

In the English shipyards the bulk of the increase was on the northeast coast, where the activity has been abnormal. The greatest amount of work was done in the Tyne district. The work in the Tees and Hartlepools district kept pace with the other shipbuilding centers, most of the product being moderate-sized screw steamers. The Thames district, as might be expected, has suffered from the lack of naval work, and it does not seem probable that this will be regained. A large amount of naval work was done in the Mersey district, including one battle cruiser, one protected cruiser, three torpedo boat destroyers and two transports for the British Government, four destroyers for the Argentine Government and one cruiser for the Chinese Government.

The two leading English Channel firms, Messrs. Thornycroft, of Southampton, and Messrs. White, of Cowes, have during the year completed and now have under construction a large number of torpedo boat destroyers for the Britsh Government. The other work turned out by the English Channel yards has been confined largely to small power boats, such as launches, pinnaces and yachts.

In the leading Irish shipyard, where such wonderful records have been made, there is a large tonnage on hand. The largest vessel now building outside of the *Titanic* is a Holland-America liner of 32,500 tons, and a White Star vessel of 18,000 tons for the Australian service. Three moderate-sized steamships for the Royal Mail Steamship Company, and one each for the Bibby and Elder Dempster lines, are in hand. The total output of the British Royal Naval establishments for the year consisted of two battleships of 23,300 tons each, two scout cruisers of 3,380 tons each; a protected cruiser and two submarines, making an average year of work for the dockyards.

In foreign countries, Germany stands in first place for the amount of tonnage produced during the year, and also the size of ships is rapidly increasing. Notwithstanding the big output of the last year, a large amount of both the naval and merchant marine work is still on hand. The largest vessel is, of course, the Hamburg-American liner *Imperator*, of 52,000 gross tons, building by the Vulcan Company of Stettin. A number of interesting oil-engined ships, ranging from 8,000 to 15,000 tons carrying capacity, are also under construction at Kiel for the German-American Petroleum Company.

France has had an unusual year of prosperity in shipbuilding. The naval work included two battleships, nine destroyers, three gunboats, two submarines and a destroyer dock. The steamship *Rochambeau*, previously described in our columns, was the largest vessel built during the year, but this is being followed by another at La Ciotat for the mail service of the Messageries Maritime to the Far East, and the twin-screw steamer *Valdivia*, built at Port de Bouc, for the Cie. Transport Maritime of Marseilles.

A Slipping Clutch for Diesel Marine Engine Installations

BY J. RENDELL WILSON

As indicated in our January issue there were Diesel-engined vessels in service in Russia long before the reversible marine oil engine was perfected, and the success of these ships was in no small way due to the Koreiwo pneumatic slipping clutch, the use of which has been so satisfactory in that country that it has been retained with 1,000 horsepower craft launched in 1911, despite the fact that these later vessels have reversible oil engines installed. In the first two boats owned by Messrs. Nobel Bros., of St. Petersburg, the Del Proposto system of electric transmission was adopted; but evidently this gear absorbed too much power, as practically all the remainder of their craft were fitted with Koreiwo clutches, as also were some ships engined for other firms by the Kolomnaer Company.

Delo, a 4,000-ton tank-ship, driven by two 500-horsepower Diesel engines, and illustrated in our January issue, has two of these clutches to each engine, one at the forward end and one at aft. Fig. 1 shows the arrangement of the starboard engine, the port engine being, of course, a duplicate. (*A*) is the four-cylinder engine (*B*) the after clutch, and (*C*) the forward clutch. When the order to reverse ship is given the clutch (*B*), which is connected to the propeller shaft, is thrown out of engagement, and the forward clutch (*C*) is automatically thrown into action. The drive is then transmitted to the shaft (*F*), which runs alongside the engine by chain drive (*M*) from the extension pinion (*E*), thence through the gear wheels (*S*). This, of course, gives a reverse action to the propeller shaft. But the Koreiwo clutch has another important feature, namely, that with its use only a fraction of the engine power need be transmitted; in fact, anything from zero to full power. This is most useful in crowded river or harbor traffic, and gives vessels so equipped all the maneuvering qualities of a reciprocating-engined steamship.

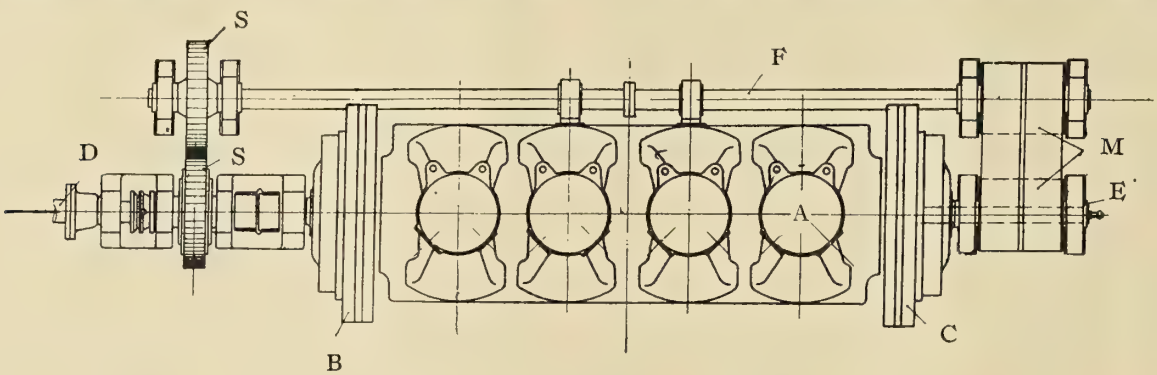


FIG. 1

Regarding the construction of the Koreiwo clutch, the design is certainly very ingenious and well thought out, and the following description should be of special interest to shipowners and marine engineers, as we do not know of a single instance outside of Russia where it has been installed in a ship. In that country, as before stated, it is widely in use, especially in connection with the big Diesel-driven paddle-boats.

Turning to Fig. 2 the fly-wheel (*C*) and the casing (*D*) are the section of the clutch keyed to the engine crankshaft, while contained in the casing (*D*) is the other half of the clutch, which is carried on the boss (*E*), the latter being keyed to the propeller shaft. To the inner plates of both faces annular copper diaphragms (*H*) are fitted, and under these spaces, which connected to the ship's compressed air supply, are formed, the connections being through the channels P^1 and *P* in the tail-shaft and plate, respectively. Similar plates, but thicker, are fitted over the diaphragms, and on the plate are fixed solid rings, which carry lignum vitæ (one of the hardest of woods known) strips (*L*).

Copper rings (*F*) are fitted to the interior faces of the fly-wheel (*C*) and casing (*D*), while radial channels are cut into the faces of the lignum vitæ strips, permitting the flow of water from the pipe (*N*) into the casing (*D*). This water is thrown by centrifugal force into the inner periphery of the casing, whence it passes through the channels (*S*) to the rim of the fly-wheel, and is then forced by inertia through the off-take (*O*). When there is no pressure under the diaphragms (*H*) lignum vitæ strips do not touch the copper rings, and the clutch is then inoperative. Upon admission of compressed air through the aforementioned inlet channels (P^1) and (*P*), the diaphragms (*H*) and the sheet springs transmit the pressure to the lignum vitæ strips (*L*), which are thus brought into contact with the copper rings (*F*), causing the clutch to immediately grip.

As the gripping power is in accordance with the pneumatic pressure under the diaphragms, it can be regulated by a manometer also, because an almost constant coefficient of friction is maintained by the continued surface lubrication. Thus the gripping power can be varied from nil to the full engine power. It may be argued that the friction surfaces will wear rapidly, but by actual practice this theory has been proved wrong. In the Koreiwo clutches constructed by the Kolomnaer Company the surfaces are of soft copper and lignum vitæ, which when lubricated with water wear exceedingly well. Generally a pressure of about 38 pounds per square inch has to be transmitted, while lignum vitæ has such splendid qualities that it can safely be loaded to 350 pounds per square inch.

For the working of the clutch in actual service let us return to the machinery of *Delo,* as this vessel has been successfully running since 1908, a fact which should make American and British marine engineers kick themselves to make sure that they are awake. Her two 500-horsepower engines develop their rated power at about 200 revolutions per minute, so the pressure in each clutch when she is at full speed (9.3 knots) is 36.7 pounds per square inch, and since the ratio between the surface of the diaphragm and the lignum vitæ strips is

3.5, the pressure between the lignum vitæ and copper friction surfaces cannot exceed 128 pounds per square inch. But at this pressure the drive is practically direct, as there is no slip, and consequently no wear. For maneuvering the ship, the engine, being fairly flexible, is generally brought down in speed to about 130 revolutions per minute, reducing the vessel's speed to about 5½ knots. It is only very rarely that a slower speed than this is required, and then only for short periods, and as the slipping of the clutch is only required for speeds under 5½ knots, it really gets very little wear.

Were the ship traveling at 3 knots the propeller shaft

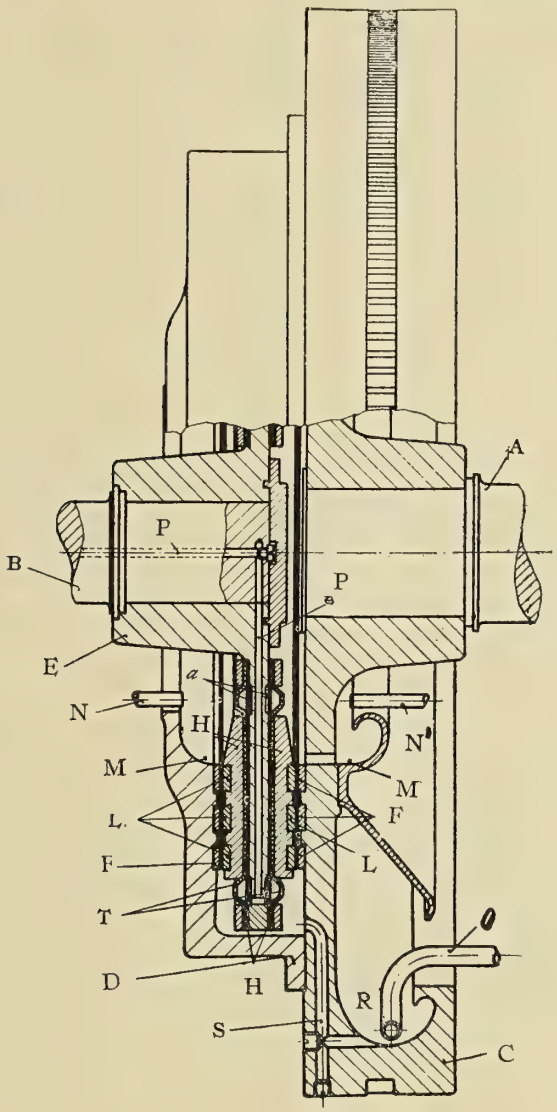


FIG. 2

would be turning at 50 revolutions per minute and the engines at 130 revolutions per minute, while the air pressure in the clutch would be 2.3 pounds per square inch and 8 pounds per square inch between the frictional surfaces. This will show how slight is the wear under working conditions, and should do much to remove the prejudice against slipping clutches held by the majority of marine engineers, as despite all theory the proof of the pudding is the eating thereof. These clutches, but of a slightly different pattern, are also used on the numerous big side-paddle tugs in service on the Volga, which are fitted with Diesel engines ranging from 300 horsepower to 800 horsepower. *Myssl*, the first of these, was built five years ago, and is owned by Messrs. Merkuler Bros., who are the owners of *Delo*.

While on the subject of Russian Diesel ships we take the opportunity to supplement the information given in our January issue. The work of carrying out Diesel installations in ships has been about evenly divided between the Kolomnaer Company and the Maschinenfabrik Ludwig Nobel, of St. Petersburg, who must not be confused with Messrs. Nobel Bros., the great oil firm and owners of Diesel ships. Ludwig Nobel engined the following vessels in Nobel Bros.' fleet: *Wandal* (360 horsepower), *Sarmat* (360 horsepower), *Belemor* (140 horsepower), *Samojed* (280 horsepower), *Robert Nobel* (700 horsepower), *Osjetin* (400 horsepower), *Leegin* (400 horsepower), *Ingusch* (400 horsepower), and *Masur* (200 horsepower). Ludwig Nobel also engined the following Russian Diesel gunboats: *Kars* (1,000 horsepower), *Ardagan* (1,000 horsepower), *Smertsch* (1,000 horsepower), *Graza* (1,000 horsepower), *Schtorm* (1,000 horsepower), and *Schwal* (1,000 horsepower). The last named was placed in service in 1909. She is driven by four 4-cylinder 250-horsepower Diesel motors, a fact which places the Russian navy in the proud position of being the most far-sighted navy in the world. *Kars* and *Ardagan* have two 500-horsepower engines apiece. The firm have also engined a number of Diesel submarines for this navy, and are constructing the Diesel engines for the 1,200-horsepower revenue cruiser launched on Dec. 16 last at Nicolieff. But the most interesting, if not the most important item to record, is the fact that Louis Nobel has perfected the light-weight high-speed marine Diesel engine, and in 1910 installed an 8-cylinder V-type motor developing 150 horsepower at 600 revolutions per minute in his yacht *Intermezzo*.

Twelfth International Navigation Congress

The Twelfth International Congress of Navigation will convene in Philadelphia May 23 next. Its sessions will be opened with a formal address by President Taft, Head Patron of the Congress, followed by a reception to the delegates of foreign nations and distinguished foreign engineers who will attend.

This is the Twelfth International Navigation Congress and the first to be held in America. Previous Congresses have been conducted at intervals of about four years since 1885, in Belgium, Holland, England, Germany, Italy, France and Austria, and the last was held in St. Petersburg in 1908.

The purposes of these Congresses, broadly speaking, are to further the progress of work in the interest of navigation. The Permanent Association which conducts the Congresses now includes thirty-five nations in its membership as well as thousands of the foremost engineers and navigation authorities of the world. Its headquarters are in Brussels, and it is governed by a commission composed of delegates from the various countries holding membership.

The proceedings of the Congress at Philadelphia will be divided into two sections—one on inland waterways and the other on ocean navigation. Some of the important subjects to be discussed are the equipment of ports with mechanical facilities for freight handling, the most economical and profitable dimensions for barge canals, the proper dimensions for ship canals, such as those of Panama, Suez and the Kaiser Wilhelm Canal in Germany; the probable dimensions of ocean steamships of the future (on which depends largely the size of docks and canals planned now); the control and improvement of navigable rivers; the use of concrete for construction seawalls, retaining walls, docks, canal locks, piers, etc., means for docking and repairing vessels, etc. Many of these subjects, particularly those relating to barge canals, river and harbor improvements, port facilities and means for docking and repairing vessels are of vital importance in America at present, and the discussions at this Congress will be of great value.

Report of the Chief of the Bureau of Steam Engineering

The annual report of Rear Admiral H. I. Cone, Chief of the Bureau of Steam Engineering of the United States navy, contains some interesting information regarding the progress which has been made in the development of the machinery for the latest warships. In addition to the usual repairs and renewals to the machinery of the fleet, work of considerable extent and involving large expenditure has been done to the machinery of a number of vessels. The preparation and examination of plans for repairs and alterations to machinery of vessels in commission and those fitting out at navy yards, and for the construction of new machinery and boilers building at navy yards and by contract, have been carried on during the year.

In the face of an almost universal adoption of the turbine for battleship propelling machinery by the nations of the world, the bureau has in the recent battleships, beginning with the *New York* and *Texas*, abandoned the turbine in favor of reciprocating engines for such vessels. This decision was arrived at after an extensive investigation, including the comparative trials of the two types of machinery in the scout cruisers *Birmingham, Chester* and *Salem*, and in the battleships *Delaware* and *North Dakota*, which render available more exact data on the subject than are available to any other government. It is found that the reciprocating engine is about 30 percent more economical at cruising speed than the turbine and has about the same economy at high speeds.

The steam turbine as now installed in high-speed vessels, notably destroyers and scouts, has greatly extended the range of speed at which these vessels may be safely and continuously driven.

It was found difficult to maintain the Niclausse boilers of the *Colorado* and *Pennsylvania* in efficient condition because of the inability to obtain special parts for these boilers at reasonable prices and without great delay. Eight boilers in each ship have been converted to a boiler resembling the Babcock & Wilcox in construction, at practically little expense, the foundations, furnaces and many of the pressure parts of the original boilers having been used. It is intended to extend this process to the other boilers of these vessels as rapidly as their condition warrants it.

The success which has attended the use of fuel oil in the recent torpedo boat destroyers indicates a probable increase in the extent of the use of this fuel for naval purposes generally. Preparations are being made at the navy yard, Philadelphia, to instruct firemen and water tenders in the methods of burning oil. A lack of such a place of instruction has greatly hindered the development of the art of oil burning in the navy.

The system of forced lubrication of the bearings of main engines has been installed on several battleships and armored cruisers, and will be installed on the others as opportunity offers. This system greatly extends the life of the engine, eliminates bearing troubles, and reduces the quantity of oil required for lubrication.

Turbine-driven blowers, which have proved so successful in the recent destroyers for supplying air to the fire rooms, are being installed on those older destroyers whose condition warrants it, thus eliminating the principal element of weakness in these vessels.

Small foundries capable of handling about 100 pounds of metal have been installed in the battleships, increasing their ability of self-maintenance and reducing cost of repairs.

There is a continual improvement in the economy of coal consumption in the vessels of the service, due principally to the steaming competition. In the direction of this economy the evaporators of many of the vessels have been converted to double effect. There has also been a development of systematic firing induced by analyses of smoke-pipe gases. Most of the largest ships have been equipped with an apparatus for sampling this gas and determining the proportion of CO_2 therein. The result of these analyses has pointed the way to improved economic conditions.

Under the spur of the steaming competition propellers which are more efficient at the cruising speeds have been fitted on the *Kansas* and *North Carolina*, and are to be installed on the *Mississippi* and *Vermont*. As soon as accurate data of the efficiency of existing propellers under service conditions can be obtained it is intended further to improve the efficiency of the fleet as a whole by replacing those propellers which are least efficient at cruising speeds.

On account of the lack of economy of the turbine when driven at the slow speeds compatible with propeller efficiency it has been found necessary to investigate the problem of coupling a high-speed turbine to a slowly revolving propeller shaft, thus conserving both propeller and turbine efficiencies. The collier *Neptune*, recently constructed, has been fitted with reduction-gear machinery intended to accomplish this end, and a similar vessel, the *Jupiter*, which is being constructed at the Mare Island navy yard, will be equipped with electric propelling machinery, in which a dynamo and motors are interposed between the turbine and propeller shafts, both without additional cost to the Government. In the destroyer *Henley* a combination of reciprocating engines and turbines is being installed for the purpose of improving the economy at cruising speeds.

The extensive development of heavy oil engines of the Diesel type that has taken place abroad within the past few years leads to the hope that eventually this type of engine will be available for use in large vessels of the navy. Progress in this country has not been so marked as abroad, but American firms are now taking up the development of this type of engine. The submarines recently contracted for will be propelled by reversible two-cycle heavy oil engines of the Diesel type, developing up to 600 horsepower each. It is hoped that satisfactory proposals can be obtained for the installation of engines of this type in the submarine tender authorized by the last Congress. The existing stage of development does not warrant taking up the engine for installation in larger vessels at this time, but it is hoped that progress in the near future will be such as to warrant this step.

During the year the fitting of sailing launches, dories and other service types of boats with gasoline (petrol) engines has been proceeded with. The collective horsepower of these boat installations now exceeds 4,250, exclusive of installations in submarine boats. The manufacture of a service design of gasoline (petrol) motor has been undertaken at the navy yard, Norfolk, with a view of standardizing all installations. The substitution of oil engines for gasoline (petrol) engines is very desirable, but thus far it has been impossible to obtain these in small units suitable for boat installations. Three types of motors suitable for aeronautical work have been purchased and will be tested during the coming year.

Continued efforts are made to improve the economy of electric installations, and tests of recent turbo-generating sets show a marked improvement over those first purchased, especially at points below full load. It has also been possible to reduce the cost of installation in new ships by increasing the number of distribution centers for lighting, thereby reducing the number of feeders piercing the protective deck. The number of lights carried by a single fuse has also been increased, with resultant decrease in the number of branch outlets. Modifications are being made in the design of searchlight bases and controlling apparatus which will permit either electrical or mechanical control, as may appear desirable.

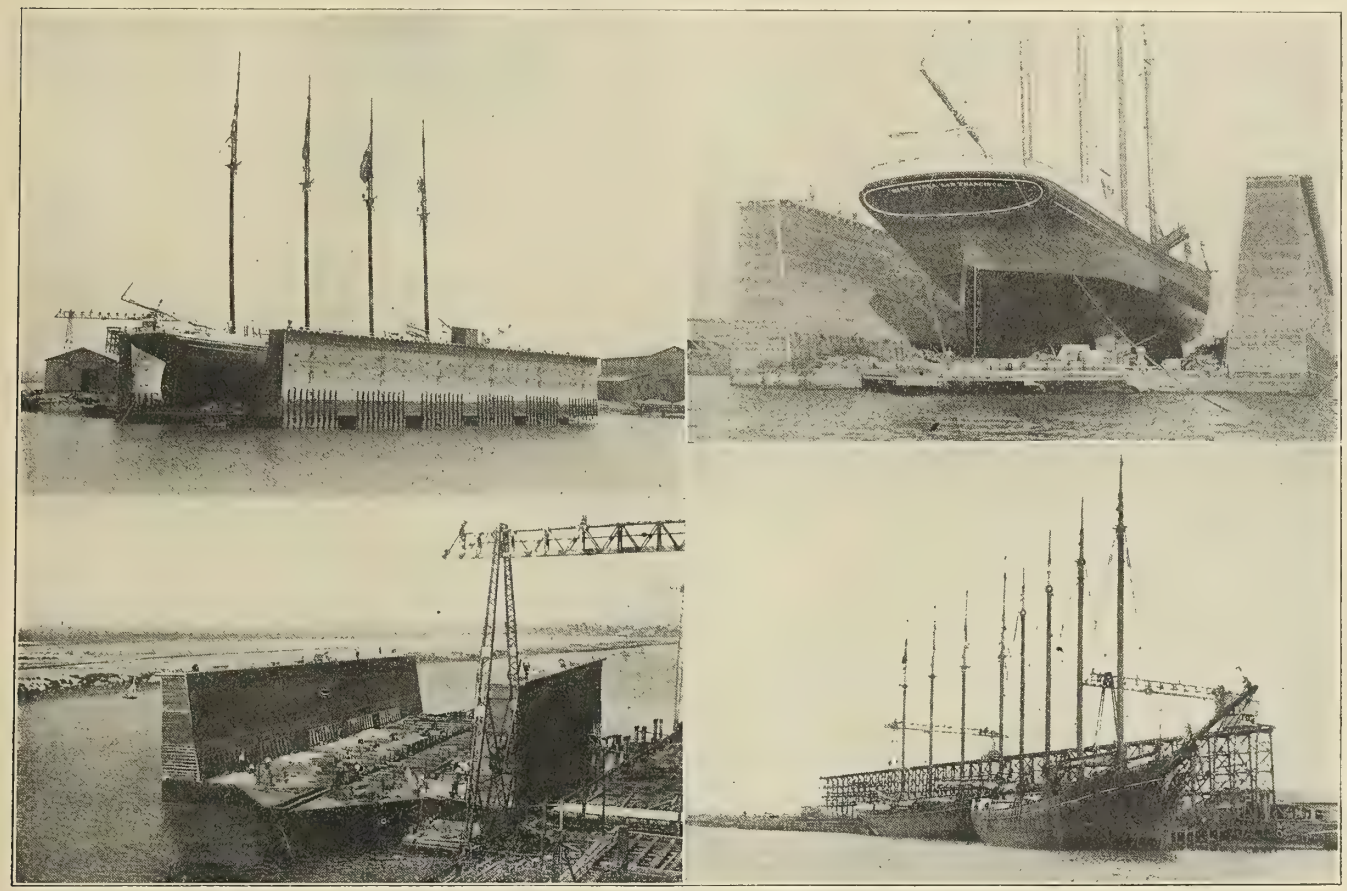
A New Pacific Coast Shipbuilding and Repair Plant

The Craig Shipbuilding Company, of Toledo, Ohio, was well and favorably known on the Great Lakes almost from the beginning of steel shipbuilding there. In 1906 this business was disposed of by sale and we next heard of the Craigs, who found it impossible to keep their hands away from the calling, in Los Angeles, Cal., where Mr. John F. Craig had gone for rest and recreation.

An examination of the water front there in connection with the then small town of Long Beach developed the possibility of a new harbor and shipping facilities. The result, under the direction of Mr. John F. Craig, was the opening up of an inlet which had been previously closed by the tracks of the Southern Pacific Railroad, by the providing of a bascule bridge with a 200-foot clear opening, which made possible the creation of a very fine harbor for the now rapidly developing city of Long Beach. For his work in connection with the developing of this harbor, Mr. Craig received the concession of 43 acres of land, upon which there has been erected a complete shipbuilding plant entirely equipped for building hulls and machinery. An ocean-going tug, a dredge and two steamers have already been built by this plant and others are under construction.

As side launching is practically universal on the Great Lakes, the Craig Shipbuilding Company has introduced this method upon the Pacific Coast, and one of the photographs shows the steel service crane which handles material with economy to ships under construction.

In anticipation of the increased shipping that will undoubtedly follow the opening of the Panama Canal, the Craig Shipbuilding Company early obtained plans for the most up-to-date and modern type of floating dry dock designed by William T. Donnelly, consulting engineer, 17 Battery Place, New York. The design of this dock provides for progressive building; that is, while the completed design contemplates a dock 293 feet long in the wings and 350 feet on keel blocks, composed of nine pontoons, and having a lifting power of 5,000 tons, the construction as provided and shown in the photographs is composed of five pontoons, having an over-all length on keel blocks of 241 feet and a lifting power of approximately 3,000 tons, which is more than ample to meet the present needs of the port.



DRY-DOCK OF THE CRAIG SHIPBUILDING COMPANY

DRY-DOCK UNDER CONSTRUCTION

END VIEW OF DRY-DOCK

GENERAL VIEW OF SHIPYARD, SHOWING STEEL SERVICE CRANES

When it is desired to extend the dock additional pontoons will be built and launched. These will then be floated in place and the wings extended over them. This can be done without putting the dock out of commission; in fact, it could be done with a vessel on the dry dock.

In this dock both the pontoons and wings are of timber construction, and are connected together in such a manner that they can be readily detached, which makes the self-docking feature a simple matter. The pontoon to be self-docked is detached, the rest of the dock pumped up and the detached pontoon floated out from under the wings, when the remaining portion of the dock can be lowered and the detached pontoon docked in the usual manner.

The construction of the dock throughout is of selected Douglas fir, put together in the most thorough and substantial manner. The pontoons are very thoroughly protected by

sheathing, and, with the accessibility for examination, little or no trouble is expected from the toredo or other marine worms.

The dock since completion has given excellent satisfaction, and the city and port of Long Beach are to be congratulated upon this addition to its harbor facilities.

The pumping equipment of this dock consists of ten 10-inch centrifugal pumps, five on each side, operated by a 100-horse-power electric motor. These pumps are capable of pumping the full capacity of the dock within one-half hour. The pumps are operated by vertical shafting from a line shaft along the top of each wing, and the individual control of the pumping is brought about by regulating the flood-gate in each pontoon through which the water is admitted and delivered. This system of controlling the pumping reduces the number of valves to a minimum, and provides a most satisfactory and simple method of operation.

The dock is fully equipped with centering shores and with bilge and keel blocks of the latest design. Compressed air is provided for operating air tools, and it is certain that this dock, in connection with the shipbuilding plant, will be able to render the most prompt and efficient service in the matter of dry docking and ship repair work.

The Canadian Pacific Railway Company's Steamer Princess Alice

The latest addition to the fleet of the Canadian Pacific Railway Company is the finely modeled passenger steamship *Princess Alice,* built by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at their Wallsend shipyard. The vessel is 290 feet long, 46 feet 2 inches beam, with a draft of 12 feet 6 inches. In many respects she is similar to the other well-known steamers previously built by the same concern for service on the Pacific coast of Canada.

She is an 18-knot ship, the main engines consisting of one set of four-crank triple-expansion reciprocating engines, balanced on the Yarrow, Schlick, Tweedy system. The cylinders are 27, 42, 48½, 48½ inches diameter by 39 inches stroke. Steam is furnished by four single-ended boilers, 15 feet 7 inches outside diameter, 12 feet long, the steam pressure being 180 pounds per square inch. Either coal or oil can be used as fuel; the oil-burning apparatus is of the Wallsend-Howden system; the liquid fuel pumps of the Weir type. California oil will be used, and this is stored in the double bottom and deep tanks. The boiler furnaces are clear of brick work. Two double inlet fans are supplied by Messrs. M. Paul & Company, Dumbarton. The condenser is of the Uniflux type, and is independent of the engine framing. Dual type air pumps are used, and all of the pumps are independent, none being connected to the main engine.

The passenger accommodations include commodious cabins, extending the whole length of both the upper and promenade deck. On the main deck aft is the dining room, paneled in beautiful Italian walnut and finished in decorations of white enamel and gold. Below the dining room is a restaurant, with seating accommodations for about 100 persons at small tables. On the promenade deck, forward, is the observation room, with large plate glass windows on three sides. At the after end of the same deck is the first class smoking room, furnished in fumed oak. The oak walls are to be relieved with hammered copper panels beautifully designed, and representing scenes of North American Indian life and various Canadian subjects. On the upper deck, both forward and aft of the engine and funnel casing, there are large social halls or music rooms. Both the ventilation and lighting of saloons, corridors, staterooms, kitchens, etc., have been carefully studied and lavishly executed. The location of the public rooms is such that the passengers can have an uninterrupted view of the magnificent scenery through which the vessel passes.

LATEST ADDITION TO THE CANADIAN PACIFIC RAILWAY COMPANY'S FLEET, THE PRINCESS ALICE

Tug Boat Frank Tenney

A steel tugboat was recently completed by the Maryland Steel Company, Sparrows Point, Md., for the Spanish-American Iron Company, for use between Santiago and mines at Daiquiri, Cuba. The hull is of steel, built to the highest class American Bureau of Shipping. The length over all is 125 feet 6 inches; between perpendiculars, 119 feet; the beam molded, 25 feet; depth, molded, 13 feet, and the draft 10 feet.

The deckhouse is of steel and the pilot house of wood.

There is one wooden mast equipped with one boom, capable of handling a load of 5 tons. The joiner work is of cypress, tongued and grooved, trimmed in oak.

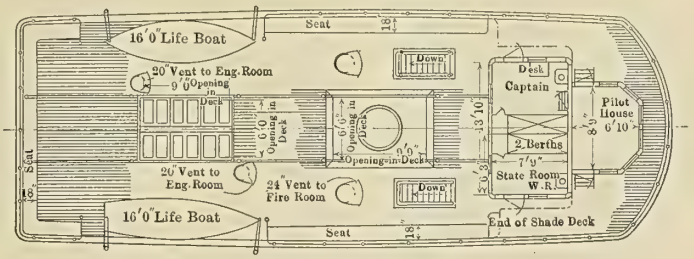
Steam is furnished by one Scotch boiler, 13 feet diameter by 11 feet long, carrying a pressure of 180 pounds per square inch. There are three 42-inch furnaces, and all the tubes are 3 inches diameter.

The propelling machinery consists of one triple-expansion engine, with cylinders 12½, 20½ and 34 inches diameter, with a common stroke of 24 inches, designed to drive the ship at a speed of 11½ knots. The condenser is of the surface type, and there are circulating, bilge and feed pumps on the main engine. The independent pumps include the sanitary, donkey, circulating and wrecking pumps. The boiler is supplied with an injector.

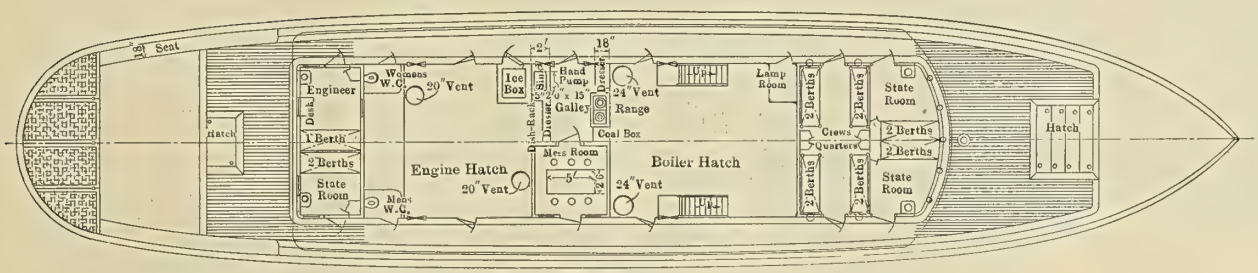
Light Draft Steamers Carolina and Virginia

The steamers *Carolina* and *Virginia*, recently built at the works of the Newport News Shipbuilding & Dry Dock Company for the Albemarle Steam Navigation Company, are intended for light draft river service. The principal characteristics of these steamers are as follows:

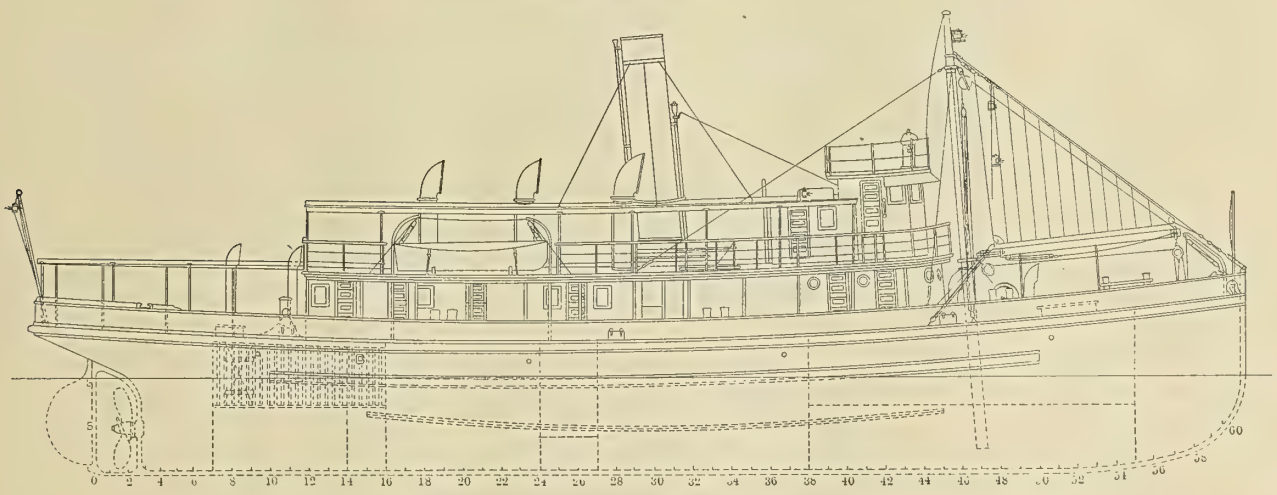
	Carolina.	*Virginia.*
Length between perpendiculars	121 feet	104 feet
Length over all	130 feet	115 feet
Beam molded	25 feet	25 feet
Beam on decks	27 feet	27 feet
Depth molded at side	9 feet	9 feet
Cargo-carrying capacity at a draft of 6 feet	120 tons	100 tons
Gross tonnage	334 tons	292 tons
Net tonnage	206 tons	179 tons
Staterooms to accommodate	18 persons	16 persons
Saloon space to accommodate	85 persons	75 persons
Crew	26 persons	26 persons
Speed	10.5 miles	9.6 miles



PLAN OF BRIDGE DECK



PLAN OF MAIN DECK



GENERAL PLANS OF THE TUG BOAT FRANK TENNEY

The deck auxiliaries include a steam windlass, winch, gypsy and steering engine. A fresh water tank with a capacity of 600 gallons is provided. The safety appliances include one 16-foot double-ended lifeboat and one 16-foot square stern boat. The general arrangement and provision for the officers and crew are evident from the drawing shown herewith.

A new 100-ton tug, the *John C. Stuart,* designed by W. I. Babcock, of New York, has just been completed by the Staten Island Shipbuilding Company, Port Richmond, N. Y. The boat is 100 feet long and equipped with powerful fire pumps.

The hull is of an extremely heavy and substantial construction. The shell plating is 15 pounds throughout. The keel plate is 20 pounds reduced to 17½ pounds at the ends, and the frames, floors, etc., are proportionately heavy. Three watertight bulkheads are also fitted. Heavy ties and stringers are worked on the decks. Steel coal bunker bulkheads with heavy coamings are also fitted. The sides of both hulls are flared out to the guards in order to protect the deck from piles, etc., when landing at the docks. The entire construction is of simple design and amply strong for the rough service in which these vessels are engaged.

The saloons present a very attractive appearance. The

joiner work and the hardware are plain and substantial. The decks in passengers' quarters are covered with the best linoleum, and the staterooms are carpeted.

Each vessel is fitted with electric lights, searchlight and generator, the generators being of sufficient capacity to light up the ship and in addition the lights which the company has installed on all their piers and in their warehouses.

The *Carolina* is fitted with a compound engine, a Kingsford leg boiler of 1,560 square feet heating surface, 42 square feet of grate surface, and carrying a working pressure of 125 pounds. It is also equipped with a surface condenser of 500 square feet cooling surface and independent auxiliaries.

The *Virginia* is fitted with a duplicate of the engine of the *Carolina,* a smaller boiler of the same type as that of the *Carolina,* designed, however for a working pressure of 145

LIGHT-DRAFT RIVER STEAMER VIRGINIA

pounds. A jet condenser is installed in this ship with independent auxiliaries.

On trial the *Carolina* developed 225 indicated horsepower, and attained a speed of 10.5 miles per hour, and the *Virginia* developed 200 indicated horsepower and attained a speed of 9.5 miles per hour.

The *Carolina* runs between Edenton, N. C., and Murfreesboro, N. C., and the *Virginia* runs between Franklin, Va., and Tunis, N. C., the latter route being on the Blackwater River, which is an extremely narrow stream with sharp bends, making it necessary to reduce the length of the *Virginia* in order that she could navigate this tortuous channel.

These vessels carry a general cargo of freight throughout the year, and at certain seasons handle large quantities of peanuts, cotton, fertilizers, etc. The holds of both vessels are arranged in such a manner as to be available for the stowage of through freight.

As these steamers are operated both day and night, the ingenious arrangement of lighting the piers and warehouses from the generators of the steamers greatly facilitates the handling of freight during the night work.

U. S. Battleships Oklahoma and Nevada

On the 4th of January bids were opened at the Navy Department, Washington, for the construction of the two new battleships *Oklahoma* and *Nevada.* Three bidders submitted bids and proposals under the eight-hour-a-day law provided for by Congress in making the appropriation for said ships. The William Cramp & Sons' Ship & Engine Building Company, of Philadelphia, while not submitting a bid, stated they could not do so because, in the event of its being successful, the company would have to adopt the eight-hour law for all the work throughout its entire plant, a condition which it at the present time considered inexpedient.

The bids of the three firms submitting proposals were as follows:

The Fore River Shipbuilding Company, of Quincy, Mass., offered to build one ship on the Department's plans and specification for $5,980,000 (£1,230,000), which is within $20,000 (£4,100) of the appropriated sum. As alternative bids it proposed to build one vessel with Curtis turbines, instead of reciprocating engines, provided by the Department's specifications, $5,935,000 (£1,220,000), or one vessel with combination machinery, consisting of Curtis turbines and connected reciprocating engines of sufficient power for cruising speeds, for $5,955,000 (£1,223,000).

The New York Shipbuilding Company, of Camden, N. J., offered to build on the Department's plans one vessel with reciprocating engines for $5,965,000 (£1,225,000). Also to build one vessel on the Department's plans, but exclusive of magazine refrigeration for $5,926,000 (£1,217,000). In each case its bids provided for the use of nickel steel in place of a special steel to be used in hull construction called for by the Department's plans. Both bids of the New York Shipbuilding Company were for reciprocating engines.

The Newport News Ship & Engine Building Company, of Newport News, Va., offered to build one vessel for $6,450,000 (£1,323,000), or $450,000 (£92,500) above the appropriation allowed by Congress.

The vessels in question are of 27,000 tons displacement, to have a speed of 20½ knots when developing about 12,400 indicated horsepower on each of two shafts. The general arrangement of the engine room machinery differs somewhat in these two ships as compared with former ships, in that the main and auxiliary machinery is placed in four watertight compartments, obtained by dividing the engine space by three fore-and-aft continuous bulkheads (the whole length of the engine room being about 60 feet).

The main engines, being placed in the outboard compartments, are of the four-cylinder triple-expansion type with two low-pressure cylinders. The exhaust from each low-pressure cylinder is led directly to its own condenser placed athwartships, there being in all four condensers, two in each compartment. In each branch of the low-pressure receiver, leading from the intermediate-pressure cylinder, there is fitted a gate valve, enabling the shutting off of either low-pressure cylinder. Besides the main engines there are placed in each outboard engine room three forced lubrication pumps, sea suctions and discharges, working platforms and operating, etc.

On each side of the center-line bulkhead there is an engine room containing two centrifugal circulating pumps, two main air pumps, one feed tank, all of which are interconnected from one engine room to the other. Besides the auxiliaries enumerated there are placed in each of the compartments in question two main feed pumps, two fire and bilge pumps, one Bureau type feed heater and one forced lubrication tank.

In the boiler room there are twelve large-tube, express-type watertube boilers for oil fuel firing only. They are arranged in three athwartship compartments with four boilers in each with one common fire-room. There is one smoke stack for all of the boilers, into which the uptakes from each boiler are led.

The time of completion for the construction of each of these vessels is thirty-six months from the date of signing the contract.

Contracts have been awarded to the Fore River Shipbuilding Company for one battleship with combination machinery of Curtis turbines and reciprocating engines, and to the New York Shipbuilding Company for one battleship with reciprocating engines.

New Menhaden Steamers for the Atlantic Coast

BY MARTIN C. ERISMANN

In July of last year three menhaden boats, completed in nine months to the order of the Atlantic Fertilizer & Oil Company, of New York, were placed in commission and are now actually engaged in fishing off the New England coast. This industry dates from the '60's, and is one of long standing, but it is only of recent years that it has been possible, through greater demand of the products of the menhaden fishing, to enlarge the plants of the companies engaged in this business. For years the boats were of small size, and though they paid well were not as well adapted, in point of view of modern arrangements, as the new boats just put in service.

The menhaden, or pogie, as the fish are nicknamed, are found in schools all along the Atlantic seaboard, from the Caribbean Sea to the Eastern Coast of Maine. The fish are detected in many ways by lookouts from the vessel, depending upon the weather and sea conditions. When a school is sighted a purse seine is shot overboard from a seine boat, two usually being carried, one on each quarter; the seine is brought alongside, and the fish dipped out and transferred to the fish hold.

A full cargo aboard, the vessel makes all speed to the factory, where the fish are placed in large boilers and then pressed to extract the oil, and the residue is used as the basis for fertilizer. It is a substitute for German potash, bone phosphate, which fertilizers generally contain. The oil finds an extensive market in the leather tanning trade and for tempering of steel, taking the place of linseed oil by reason of its cheapness and efficiency. For lighting purposes in mines it is used for its uncombustible properties.

The vessels which are the subject of our description are the *Martin J. Marran, Rollan E. Mason* and *Herbert N. Edwards.* They were built under the direct supervision of Capt. N. B. Church, of Tiverton, R. I., manager of the fishing department, Atlantic Fertilizer & Oil Company. Capt. Church has always been identified with the menhaden fisheries. In 1860, realizing the possibilities of a steamer, he and his six brothers, who were all interested in the pogie business, commissioned Nat Herreshoff, of Bristol, R. I., to built a vessel, which was subsequently called the *Seven Brothers.*

The new vessels were designed by the firm of B. B. Crowinshield, naval architects and engineers, of Boston, Mass. The three hulls were built, two by Cobb, Butler & Company, of Rockland, Me., and one by A. D. Story, of Essex, Mass. The machinery installation was put in the hands of the Portland Company, of Portland, Me. The boats are of the usual type of vessel for this trade, except that they are larger and better equipped in every way, from a point of view of efficiency, speed and comfort. The dimensions follow:

Length over all	165 feet.
Breadth	23 feet.
Draft (loaded)	12 feet 9 inches.
Depth	13 feet.
Indicated horsepower	600
Speed	13 knots.
Capacity of fish hold	4,000 barrels.

The hulls are of wood, the keel, stern, sternpost and deadwood of oak, the framing of white oak, the planking and ceiling hard pine, 4 inches thick, with hard pine bilge strakes. In the vicinity of the boiler a steel beam with large gusset plates was worked in to tie the boat together. It was the intention to work under the planking at the line of the main deck a steel stringer to strengthen the top member of the structure, but these were omitted owing to possible delay in the date of delivery.

MENHADEN STEAMERS ON THE STOCKS

The accommodations consist of a two-story deck house forward and a house located on the raised poop aft, part of the after house comes over the engine and boilers, and in the forward end is located a winch room. Two large hatches in the waist give access to the fish holds. The crew of twenty-eight men is housed in the forecastle below the main deck, forward of which there is a chain locker and store room; the house on the main deck is given over to the mess room and galley; above is the pilot house, aft of which is the captain's room, with two berths and a guests' cabin, also fitted with two berths. A toilet and wash room is located to port.

The forward end of the after house is given over to the deck winch for handling the dipping scoops to get the fish from

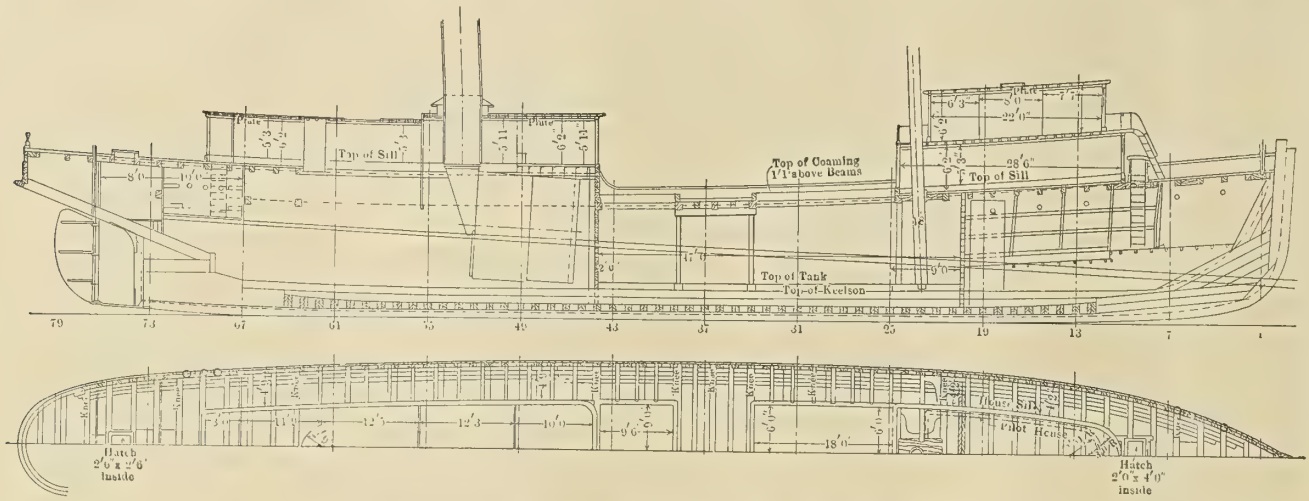
the seine to the fish hold. The hoisting engine is a Hyde cargo winch, with cylinders 10 inches by 10 inches, and capable of handling 4 tons.

Aft of the winch room is located the boiler casing, engine room skylight, chief engineer's room and a cabin for the mate and pilot. A toilet is fitted in after port corner, and is accessible from the deck: to starboard is located the entrance to

Length	13 feet 2 inches
Diameter	15 feet 7 inches
Shell	1 ¼ inches thick

258 tubes (No. 1 B. W. G. seamless drawn steel) and 58 stay tubes ¼ inch thick by 3 inches diameter.

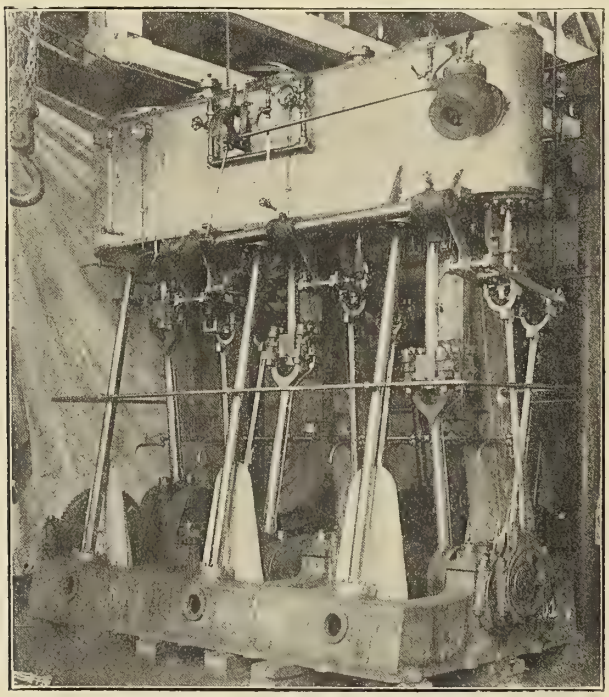
Heating surface	2,521 square feet
Great area	68 square feet



INBOARD PROFILE AND DECK PLAN OF THE MENHADEN STEAMERS

the after cabin on lower deck, to accommodate eight men at the height of the season, when double crews are carried, to man four seine boats, which are then carried. In the run a store room for nets and salt is fitted. The rudder gear is of the hand type, and stocks of steel fitted with wooden blades.

The appearance of the vessels is very good, and their ability as fast, economical and comfortable boats leaves nothing to



TRIPLE-EXPANSION ENGINE FOR ONE OF THE MENHADEN BOATS

be desired. The engine installation, which is very complete, has been successful and given no trouble, and with the vigorous conditions of service imposed, which preclude time off for repairs, simplicity and handiness were the keynote of the design.

The boiler of the single-ended Scotch type is fitted with three Morison suspension furnaces. The particulars follow:

Working pressure	180 pounds
H. S. to G. S.	37 to 1
Coal per square feet of grate per hour	17 pounds
Water evaporated per pound of coal	9 pounds
Pounds of water evaporated per square feet of grate per hour	153 pounds

The engine, of the three-cylinder, inverted triple-expansion type, with cylinders 13½ inches by 21¾ inches by 36 inches diameter, and 24 inches stroke. On trial, the engines developed 606 horsepower, at a steam pressure of 180 pounds, with 132 revolutions per minute. The engine was designed to be as simple in construction and operation as was consistent with economical operation and protracted service, with a low cost of up-keep and a minimum of repairs. The cylinders, cast separately, of a tough grey iron, are bolted together; relief valves are fitted, all being 1½ inches and set at 195 pounds for the high, 100 pounds for intermediate and 30 pounds for the low. The supporting brackets have the slides cast on, and the front columns are of the forged type. The valves are all of the piston variety, there being two on the low-pressure cylinder and one each for the high and intermediate-pressure cylinders. The cross-heads are of cast steel and lined with composition jibs; the valve gear is of the ordinary link type, fitted with a steam cylinder, a lever handling both the reverse gear and throttle, insuring quick and positive operation when maneuvering or coming alongside the dock to discharge fish.

The bed plate is cast in one piece, with large flanges and reinforcing webs. At the after end there is cast on a bracket for the hand pinch wheel. The bearings on the bed plate are six in number, with ample surface to prevent heating under any circumstances, the lining being of Parsons anti-friction white metal. The crankshaft is of forged steel and of the made-up type, 8 inches in diameter and solid, and forged by the Cape Ann Anchor Works. The connecting rods are of forged steel, with brass boxes at both ends; the lining of the boxes is of Parsons white metal.

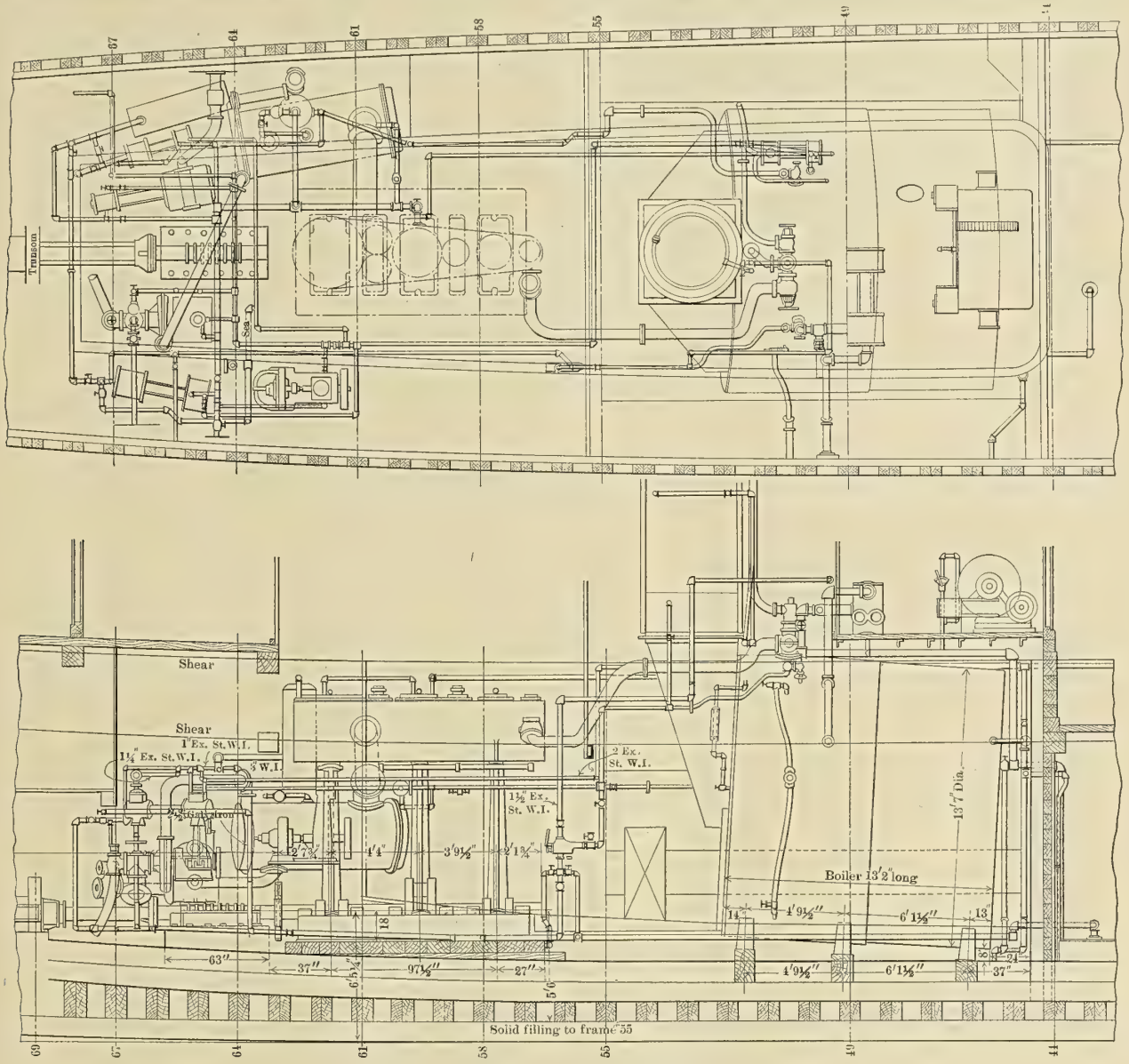
The oiling system is a combination of what has been proved to be in this type of installation the best for the purpose, and consists generally of a reservoir located on the starboard top of each cylinder. Pipes are led from each of the six compartments of each reservoir by means of wick feeds to the

points of lubrication. The slides are fitted with water circulation to obviate heating, giving better lubrication by reason of the lower temperature. The valves are of cast iron and of the piston type.

The weight of the engine complete is about 20 tons. The condenser, 94 inches long by 38 inches diameter, is separate from the engine and is cylindrical, the tube sheets of composition 7/16 inch thick, with 800 5/8 inch diameter brass tubes, and a cooling surface of 912 square feet.

searchlight, 14 inches diameter and 20 amperes, is fitted on the pilot house. An ash ejector of the Portland Co. type discharges 8 inches above the waterline. The main steam piping is of copper, 5¼ inches diameter, as are all other steam lines under pressure, other piping of extra strong and standard wrought iron pipe.

The coal bunkers, of 10 pounds steel plating, have a capacity of about 75 tons of coal. The water tanks placed in the bottom of the fish well contain 7,800 gallons of water.



MACHINERY ARRANGEMENT OF THE MENHADEN STEAMERS

The circulating and centrifugal pump were manufactured by the Morris Machine Works, and are both fitted with a 6-inch by 6-inch cylinder and 7-inch suctions.

The sea suction is 3½ inches diameter to the auxiliary feed pump, which is a 7½-inch by 4½-inch by 10-inch Blake horizontal duplex. The air pump is an 8-inch by 14-inch by 12-inch Blake horizontal simplex. The boiler feed is a 6-inch by 14-inch by 6-inch Blake horizontal duplex, and the boiler circulating pump 5¼-inch by 3½-inch by 5-inch Blake horizontal duplex.

An electric outfit of 5 kilowatts, 110 volts capacity, at 425 revolutions, consists of a Portland Company standard generator on the same bed plate with a Sturtevant 5-inch by 5-inch engine. This outfit gives thirty lights all through the ship, and will stand an overload of 30 percent. A Rushmore

The thrust block is of the usual horseshoe type, with eight collars faced with babbit. The propeller is 8 feet 6 inches diameter by 11 feet 8 inches pitch, solid, four-bladed, manufactured by the Front Wheel Company of Albany, N. Y.

The boats have, since being put in service, proved to have exceeded their speed, and the specified capacity of 4,000 barrels was entirely met. At sea, in rough conditions, either light or loaded, their behavior has been satisfactory, having such stability as makes them easy, comfortable and habitable.

A twin-screw passenger steamer of 17,050 tons displacement and 10,000 horsepower has been contracted for with the Vulcan Shipbuilding Company, Stettin, Germany, by the Scandinavian-American Line. The ship will be 540 feet long, 62 feet beam, 41½ feet depth, with a designed speed of 17 knots.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Broken Crankshaft

One accustomed to marine engines for freight steamers will always consider an engine for a hopper-dredge to be of very heavy design, the crank shafts being at least 15 percent more in diameter than Lloyds or Veritas require. The following will show that this may be necessary.

On the steam hopper-dredge "N" a triple-expansion engine of about 600 indicated horsepower, working with 160 pounds steam pressure, and making 140 revolutions per minute, was used to drive the large sand pump. The suction pipe was connected directly to the pump suction, and no grating was fitted in the suction pipe. This vessel was used for the deepening of a sea harbor. There were many stones, large and small, to be removed, and when the pump was working it made such a terrible noise that nothing could be heard in the engine room. One day it was found impossible to start the engine. The turning worm gear was put in, and with a tackle on the end of the turning lever the engine was moved, breaking a large stone, which allowed the engine to be started.

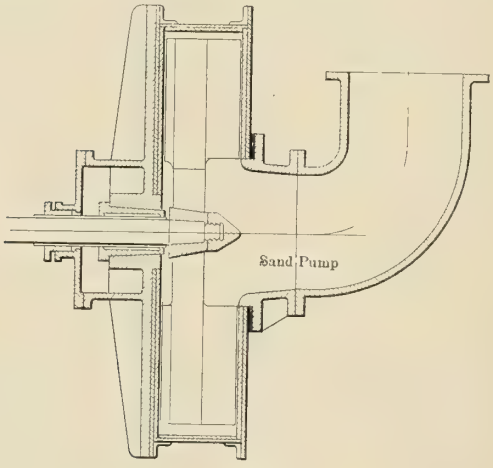


FIG. 1

Some days afterwards, again a terrible noise was heard in the pump and immediately the engine raced badly. After stopping it was supposed that one of the vanes of the pump was broken; but, after taking off the cover and examining the pump, all four vanes lay on the bottom of the pump. A new set was ordered and put in place; it was made heavier than the first. For a week the engine ran very well until a place was reached where many stones had to be sucked away. The pump then began to make much noise and some hours after the starting a heavy knock was heard and again the engine began racing. But now it seemed that the pump shaft had been broken.

It was clear that something else had to be done, as it was impossible to continue the work as things were. The suction pipe led directly to the pump suction. This arrangement was now altered. A large tank made of ½-inch plates and 3-inch angles was built in the ship close to the pump's inlet branch; on the top of the tank the suction pipe was connected. The tank had a large cover bolted on, allowing all stones to be cleared away.

This seemed to be a good arrangement, as all large stones were drawn into this tank and not into the pump. It often occurred afterwards that the pump did not work on account of the accumulation of stones in the tank, but they could now be easily removed; a sluice valve was fitted on the top of the tank to prevent a large quantity of water filling up the suction pipe.

Figs. 1 and 2 show the old and new arrangements. From the foregoing it is clear that in a dredge the crank shafts must be very heavy and the turning gear very strong, and the whole engine heavier than a common marine engine. Auxiliary steam pipes for admitting steam direct to the medium-pressure and low-pressure receivers should be fitted, as it is often impossible to start the engines when taking steam in the usual way, owing to the stones, mud and other matter accumulated in the pump; but this, of course, gives a high steam pressure in the receivers and cylinders, the walls of which must be made much stronger to withstand this extra strain.

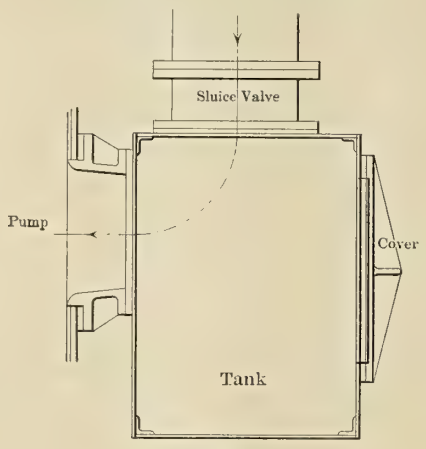


FIG. 2

ENGINEER.

A Little Experience

Strange, isn't it, what a great deal of damage can be done on board a ship, if, from one cause or other, an engineer, or assistants, fail in some little duty or other? Perhaps being a little slack in methods could account for the "failing to do."

A boiler becomes short of water, high-pressure steam, and brisk fires. It may be that in feeding a set of boilers this particular one has been keeping a steady waterline, and the valve allowing such a good regular feed that the "engineer on the watch" has been giving more attention to the others than he gives this one. It has been keeping a steady feed for watches; but, for some reason or other, the check valve stuck. It does not take long, when you are maintaining 210 pounds of steam and doing twenty-one knots, to evaporate water from a working level to a dangerously low degree. The failure of the check to work has been overlooked because of some little trouble elsewhere in the boiler room. The line above needs no filling in, we know. The engineer in the engine room has failed to detect the gradual warming up of the crank pin, for it has given absolutely no trouble for trips.

What is the result? In the case of the engineer on the boiler, so in this. He may be lucky—he may not. Now all this brings back to me a little experience I had a couple of years ago while engineer on watch in a foreign port.

We had two main boilers connected up for port use—donkey boilers—which arrangement always held, as the electric lights, refrigerator, and deck machinery were always working in port. These two boilers were each equipped with two separate feed pipes and checks, one set being from the main and the other set from auxiliary valves. Both were the same size pipes and valves, but connected to the boilers in regular fashion, the main checks being at the passage side of the boilers for ordinary use at sea, and the auxiliaries at the other side, which at no time was confusing.

In port we had two firemen on the donkey boilers, one being in charge, and a reliable man, and the feeding of the boilers was left with him. There were three watches, with two men on each watch. Now, although the boilers were looked after well by the firemen, the junior engineer of each watch had to take a periodical walk round and examine things, and report to the senior engineer of his watch. This was at such times that the engine room staff would not be down below overhauling, for then there would always be some one around. On Sundays, in port, however, it is obvious that the presence of the engineer below all the time, everything going smoothly, would not be required. I have explained just how the watch was set, who was on watch and who was in charge, so it can be the more readily understood how the following came about.

This particular watch was Sunday afternoon, the engineers relieving about one o'clock and the men below changing at two. In the morning a burst had occurred in the auxiliary feed pipe, and the engineer on that watch had been obliged to change over on to the main feed. He reported this to his relief, as the pipe would have to be removed to the repair shop on the next day, and the firemen changing would be notified by the firemen going off. Here is where the trouble began. The firemen forgot to notify their relief, and the engineer, not noticing the time, had let two o'clock pass and had failed to see the relief come on, as he should have done. Everything was all right at two o'clock.

About twenty minutes past two the electric lights went out. This is all the alarm that was needed on that occasion. We all ran down the engine room ladder, and, passing the electric platform, found the man in charge there had shut off his engines, as a heavy knock in the cylinders gave an indication of water. We raced through to the boiler room and met the fireman coming out to find us. He said he could not get water in one boiler while the other one had filled up, although he had the valve shut. The feed pump was working well, but we slowed it down. When the fireman showed us the check valves we saw at once what was the matter; he was operating the checks which had been shut off, while the main checks (which had been put into commission since the last time he had been on watch) were in exactly the same position—one open and the other almost shut—since he relieved his mate. One engineer opened the blow-off valve from the full boiler, and one of us quickly ascertained how long the water had been out of the glass of the other, for while one had a full glass and only knows how much higher, the other was minus a reading the other way. The fireman said he was just coming up as the water had just gone out of sight. A very sorry plight, but we opened the check valve to the "empty boiler" and closed the other. The water just showed in the bottom of the glass, as the other boiler, due to blow-down operations, was just level with the top of the gage. A sigh of relief went round, because it was a few minutes before the water showed. No undue risk had been taken, of course, as the water, we knew, would be well above the crown plate; but when these things happen during the quiet of a Sunday afternoon, lights out, and one boiler with a full glass and the other with a full "steam" glass, all in a few minutes, and the thoughts of "what might have been," make one breathe a sigh of relief when all is fixed right again. The electric light was started and found that all was well.

The only thing that this experience brought about was what I mentioned in the beginning of this letter: "Do not be slack in methods," even if you know all is well. This man had been opening the wrong checks, because his relief had failed to tell him of the change, and the engineer had just overstepped the relief of the men below by twenty minutes. The fireman had noticed the water getting higher in the one boiler, but had shut the check which had no connection from his pump, leaving meanwhile the main check almost full open. When he found the other boiler losing water he opened the check (auxiliary) more and started the pump quicker. This gave the full boiler more mater. I suppose the queerness of the thing must have puzzled him, and when he was debating with himself as to the best thing to do the lights went out. That decided the question for him. He should have called the engineer at the first sign of trouble, but this he failed to do. The junior engineer was down below every fifteen minutes after that during that watch. He had had enough for one watch. N. A. Y.

New York.

Rivet Out of Ship's Side Under Water Line

Every sea-going engineer is fairly strongly impressed with a knowledge of what is meant by the static head of water. It is not everybody, however, who has seen it applied in such a startling manner as occurred during the voyage of an oil tank steamer. The demonstration arose out of the snapping of a rivet in the ship's side. The rivet fell right out and the rivet hole was considerably below the level of the water line. As the engine room lay the full width of the vessel, the first thing that drew the attention of the engineer to the occurrence was a solid stream of water squirted right across the engine room, falling, as luck would have it, full on the dynamo. The commutator promptly flashed over, and all the ship's lights were put out. As hurry-up measures were necessary, a wooden plug was quickly made and hammered into the hole. This stopped the water for a while, but owing probably to the working of the vessel, the plug kept coming out and giving the engineers douche baths. These, though highly recommended by the doctors, occurred at inconvenient times, so that it was resolved to try something more permanent.

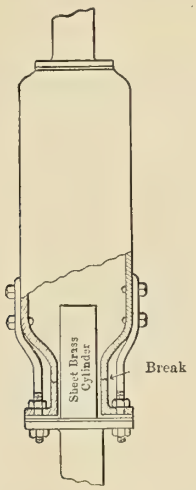
A long strip of wood was first secured which could be passed through the rivet hole. To the middle of this was fastened the end of a long piece of sail-twine. While this was being done a long bolt was taken and screwed down to within an inch of its head and a broad washer was put on to it. In front of the washer was placed a small rubber joint. When all was ready the vessel was stopped and the plug was taken out of the ship's side. The long strip of wood with the string attached to it was pushed through the hole and allowed to float to the surface outside the vessel, the string being paid out to allow for this. When it reached the surface it was pulled up to the deck and the string was taken off the wood and fastened to the end of the bolt. The bolt was next dropped into the sea and by means of the sail twine it was hauled up to the rivet hole and by careful management worked into the hole. The end of the bolt coming into the engine room was then held by the fingers while another rubber joint was put on. This was followed up by another broad washer and then a nut, which was screwed up hard. This made a sound job of the repair, and no further trouble was experienced from this cause.

Southampton. T. D. L.

Repairing a Delivery Air Vessel

Some years ago, while our ship was lying in harbor at Port Louis, Mauritius, the delivery air vessel (cast iron) belonging to one of our bilge pumps was accidentally broken. The break being, however, a clean one, we had little difficulty in effecting a successful repair.

As may be seen from the accompanying diagram, the fracture occurred across the throat of the air vessel at its lower or inlet end. To make good the damage we constructed a flanged cylinder of 1/16-inch sheet brass, making it small enough in diameter to fit loosely into the throat of the air vessel, and of a length sufficient to reach for several inches up into the chamber; in the flange of the cylinder holes were, of course, cut to correspond with those in the flanges between which it was to be fitted. Two wrought iron palm bolts were also made, and on these being properly secured in the required position on the sides of the chamber the whole outfit was built up as shown. The job was completed by pouring into the chamber a grouting of live Portland cement till it filled completely all space around the brass cylinder. The outlet pipe from the top of the air vessel was then carefully rejointed, and, to give the cement a chance to set, every-



FRACTURED AIR VESSEL

thing about that air vessel was left undisturbed for the remainder of our time in port.

In dealing with Portland cement it is well to remember that in setting it expands; also, that if the setting can by any means be retarded, the result, according to expert opinion, will be an enhanced ultimate strength, this strength being reached in about six months' time.

Notwithstanding the fact, however, that in our case the cement had only a few days in which to set before it was tested, the result of that test was all that could be desired, for there was not even a "weep" from the fracture then, nor all the time that the air vessel remained in service. Apart from other considerations, there can be little doubt that the comparatively unvarying temperature of our bilge water, and the consequent non-occurrence of any great degree of expansion or contraction in our bilge pump pipe lines, etc., had much to do with the job turning out so satisfactorily.

On arrival at the ship's home port, a new air vessel was fitted; but a good while afterwards, in walking round the repairing shop, I was rather pleased to notice the damaged air vessel where it had been thrown aside still "all sticking together" after, no doubt, much rough handling in foundry and fitting bay.

With regard to suction air vessels, concerning which interesting reference was made by a contributor in the June number of INTERNATIONAL MARINE ENGINEERING, I may say that in a Frühling dredge, on which I did duty for several years, the main pump suction pipes were fitted with suction air vessels. Strictly speaking, they should be called vacuum chambers; our gages sometimes indicated as high as 29 inches of vacuum, this taking place when the "slobber-box" at the "business end" of our suction pipes got buried in the material being dredged.

As dealing with the subject of suction air vessels, the following excerpt from one of the I. C. S. text books may be quoted:

"With a long suction pipe or a pipe having numerous bends and valves, the resistance to the flow of water through it will be considerable, and a great deal of force will be required to start and stop the water in it with each stroke of the pump. In some cases the force required is so great that the pressure of the atmosphere is not sufficient to set the column of water in motion quickly enough to fill the pump chamber as fast as the piston moves. This makes the action of the pump imperfect and causes a severe blow, called the water hammer, when the piston again meets the inflowing water.

"The difficulty can best be remedied by the use of a chamber called a vacuum chamber, or a suction air chamber, attached to the pipe as near the pump as possible.

"In its general form a vacuum chamber resembles an air chamber; but the pressure in it instead of being greater is always less than the atmospheric pressure. When the pump is drawing water, the air in the vacuum chamber expands and forces the water below it into the pump; at the same time the pressure of the atmosphere forces water in through the suction pipe to balance the reduced pressure in the vacuum chamber. The vacuum chamber is again partly filled and the air in it is compressed during the discharge stroke of the pump. It thus acts as a reservoir that receives from the suction pipe a nearly steady supply, which is given up intermittently to the pump.

"For ordinary cases, the vacuum chamber may be made half the size of an air chamber working under the same conditions. A good rule is to make the cubic capacity for a single pump twice that of the displacement of the piston for a single stroke.

"Suction and delivery air chambers should, if possible, be placed at a bend in the pipe and close to the pump, and in such a position as to be in line with the flow of water in the pipe. If placed at right angles to the flow of water their efficiency is somewhat impaired." MARK NESBIT.

A Noise and the Cause

Everybody hates noise when the cause is not understood. A brand-new engine is supposed to run pretty slick, and the one put in the *Brownell* did for about two weeks, when after starting the engine, if it had been lying idle a few hours, a curious knock was developed at each end of the stroke. It was decided that it must be the crosshead brasses, but no amount of adjustment which we could make in them obviated the noise. Then we thought it was in the crankpin brasses, and we took up and slacked off and argued and jawed, but the knock was there. Finally, we took off the cylinder head and expected to find a loose piston nut, but there was "nothing doing." We all got off no end of chuckled-headed remarks about what made the knock, but no one of us could find it. Then I got the idea that the trouble was in the rings, and took the cylinder head off again, pulled out the piston and found nothing the matter with the rings, so I closed it up again.

When I told the chief, he asked me if I had noticed there was no counterbore in the cylinder. I said there was a counterbore. He told me there was not. Then I went to the

oiler who had helped me take the head off and asked him. He said there was a counterbore. Then I thought I had the chief, and made him a bet that there was a counterbore, and the oiler, hearing of this, made a side bet with him. We were both sure. Then we took off the cylinder head, and behold there was no counterbore, and the chief had the laugh on us, and our money.

There happened to be a mate aboard the boat who was almost human, and he knew quite a little about machinery, and he heard of the bet, and came to me and said there was something queer about that bet, as he knew there was a counterbore in the cylinder because he had seen it when I first took the cylinder head off. I promptly made a bet with him, as did the captain and the oiler, and then we opened up the cylinder again, and there was a counterbore. Well, we all talked some. A little while after that there was trouble with the steering gear, and a man came down from the shop that built the engine. When he got the gear in shape he came into the engine room to put in a little extra time to help the boss, and, incidentally, himself. He asked about the engine, and whether I had noticed that the cylinder had a liner in it. I said no, it didn't have a liner, but he said yes it did, as he had turned it up and fitted it. Then I told him about the knock. He scratched his head, and suddenly remembered that he had to get back to the shop. I began thinking about the counterbore, and to make a long story short I found that the liner had been put in because the bore of the cylinder was bad, and to save it a liner was resorted to, and it was pretty thin, and the fit of the cylinder head was very free. But the

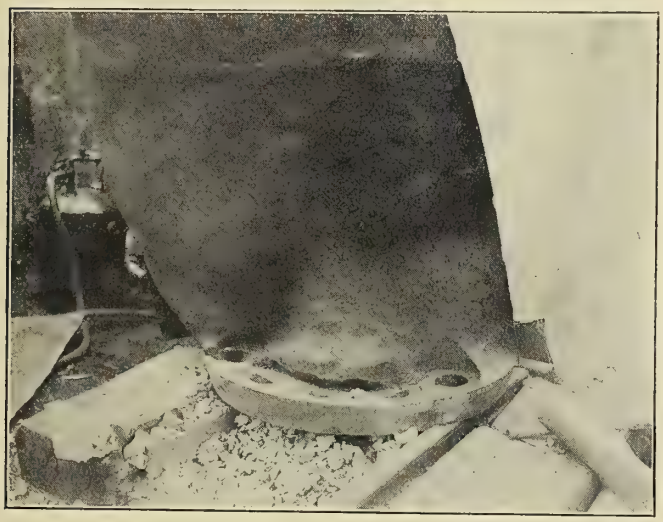


FIG. 1.—FRACTURED BLADE PREPARED FOR WELDING

worst of all was, the chap who fitted it had cut the liner off too short, and, not wanting a "call down," had let it go, and it was not pinned in any way. Now when the cylinder heated up this liner worked loose, going back and forth with the piston and knocking on each end. Of course, when the piston started on the up-stroke it carried the liner with it, and on account of the loose fit of the cylinder head it was able to fetch up at the joint, and when we first opened up the cylinder this condition existed, consequently there was no counterbore, and when on the down-stroke the liner was carried with the piston, of course there was a counterbore.

The builders had to give us a new cylinder, but we are arguing yet about whether those bets shouldn't be declared off and the money returned; but we haven't got that settled yet.

KNOCK.

The Red Star liners *Kroonland* and *Finland* have returned to American registry after flying the Belgian for three years. Both ships were built in 1902.

Unique Repair to a Two-Ton Cast Iron Propeller Blade

The steamship *Pretorian* recently carried away one propeller blade, and on placing the ship in drydock a fracture was found in the flange of another blade, as shown in the photographs. As there was only one spare blade available it was decided to treat the fractured blade by the oxy-acetylene process and further to reinforce the blade, as shown in the sketch.

FIG. 2.—COMPLETED WELD

The fracture extended along five holes and right through the flange. This was chipped off for a breadth of about 2 inches,

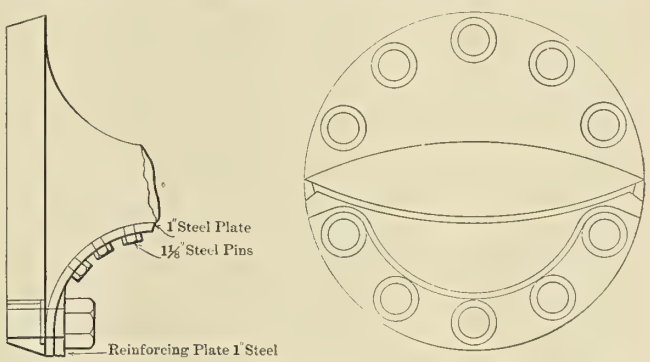


FIG. 3.—SKETCH SHOWING LOCATION OF FRACTURE IN PROPELLER BLADE

and about 200 pounds of high-grade cast iron was fused into this place.

The repair was carried out by the Halifax Dry Dock Company, Halifax, N. S. This firm has recently installed an up-to-date oxy-acetylene plant. One job which was accomplished by the plant was the cutting of a 10-inch rudder stock completely through in fifty-two minutes.

The plant, business and good will of the Moran Company, Seattle, Wash., were purchased Dec. 30 by the Seattle Construction & Dry Dock Company. The new company will make some important general improvements to the plant and equipment, and in addition now have under construction a 12,000-ton floating dry dock. This dock will be the largest of its kind on the Pacific Coast, and will give the company ample facilities for docking the largest vessels entering Seattle.

Mr. J. V. Paterson, president and general manager of the Moran Company, holds the same position with the new company.

Review of Important Marine Articles in the Engineering Press

Chinese Training Cruiser Ying Swei.—Messrs. Vickers, Ltd., have recently completed at their Barrow-in-Furness works a training cruiser for the Chinese navy which excels in the comprehensive character of the provisions for the effectual training of officers and men for naval service. It has been the aims of the designers to provide all the fighting capacity possible in a ship of this size, to install as great a variety of guns and machinery as possible for the practical training of the crews, and the ability to easily maintain a high rate of speed. The first of these is obtained by the use of 6-inch, 4-inch, 14-pounder, 3-pounder and 1¼-pounder guns and two torpedo tubes; by extra stores of ammunition of all sizes, and an extra thick protective deck for a cruiser of this size. The second purpose has been carried out by providing both watertube and cylindrical boilers, and, wherever consistent with good efficiency, the use of alternative systems of auxiliary machinery. The third of these aims has been met by the installation of Parsons turbines driving triple screws. The trials have been completed in a satisfactory manner and all conditions of the contract were met. The principal dimensions of the ship are: Length between perpendiculars, 330 feet; breadth, molded, 39 feet 6 inches; depth, molded, 23 feet 9 inches; mean draft, 13 feet; displacement, 2,500 tons; speed, 20 knots. 1,700 words with photographs and drawings.—*Engineering,* December 22.

Description and Trials of United States Torpedo Boat Destroyers Warrington and Mayrant.—By W. B. Robins. Torpedo boat destroyers, Nos. 30 and 31, the *Lewis Warrington* and *John Mayrant,* belong to the first group of oil-burning destroyers of our navy, and have the first installations of Zoelly turbines for naval purposes in this country. Contract for these ships was made Oct. 1, 1908, with the William Cramp & Sons Company, and they were delivered in March and July of 1911. A few of the principal specifications are: Length over all, 293 feet 10½ inches; molded breadth, 26 feet 4½ inches; depth molded to main deck, 16 feet 4¾ inches; draft, 8 feet 4 inches; normal displacement, 742 tons. The main engines consist of two Zoelly compound impulse turbines on two shafts, each having a backing turbine in the after end. Designed horsepower is 13,000, at 650 revolutions per minute, with steam pressure of 250 pounds. The propellers are three-bladed solid manganese bronze wheels machined to true pitch. Diameter is 6 feet 8 inches and pitch 6 feet 2 inhes. Steam is supplied by four White-Forster watertube oil-burning boilers in two fire-rooms and having three smoke stacks. Oil burners are of the Schutte & Köerting type. Complete description and data from trials, which were reported satisfactory, are given in the article, together with photographs. 15,000 words.—*Journal of the American Society of Naval Engineers,* November.

The Cunard Liner Laconia and the Rolling of Ships.—What is called the most important application of the Frahm system of anti-rolling tanks has been installed on the Cunard twin-screw ship *Laconia.* This vessel, a sister ship of the *Franconia,* recently put in commission, is designed for the Boston service. Her general dimensions and specifications are: Length over all, 625 feet; breadth, 72 feet; registered gross tonnage, 18,150 tons; displacement, 25,000 tons. There is carrying capacity for 300 first class, 400 second class and 2,000 third class passengers and 7,000 tons of freight. The chief feature of scientific interest is the anti-rolling tank to prevent the ships rolling when the sea is abeam. A U-shaped 'thwartship tank is fitted and connected along the horizontal line. When waves synchronize with the period of roll of the ship, the water in this tank oscillates with a period equal to the individual period of the ship, but with a difference of phase of 90 degrees. Thus a tendency to counteract the impulse to roll is formed, depending in size upon the volume of the tank and the loading and size of the ship. In this ship the tanks, for there are two of them, are placed forward in the 'thwartship bunkers, where they do not interfere with the arrangement of the ship. They extend the width of the ship and for nine and six-frame spaces, respectively, fore and aft. The connecting passage between the side basins is placed on the double bottom. Each tank has an air valve and piping to pumps for filling and emptying, for use is made of them only when the ship is actually rolling, otherwise they are carried empty. Only sufficient space of the system is used as is necessary to damp the rolling of the vessel, and since the two tanks are entirely independent either one or both may be used. A gyroscope-pendulum is fitted for the measurement and recording of the rolling motions of the ship. This instrument consists of a gyroscope rotated by an electric motor, which remains steadily in the same vertical position. The frame of the instrument rolls with the ship, and its relative position to the wheel is traced on a strip of paper wound up on a roll by a motor. Trials of the apparatus were made, but not at a time when the ship was subject to a heavy swell. It showed clearly a difference in the variety and extent of the ship's rolling when the tanks were in use and when not in use. The results were in general encouraging, but further use will show better in detail what may be expected from their general adoption. 4,000 words and drawings.—*Engineering,* December 15.

Description and Trials United States Torpedo Boat Destroyer Patterson.—By W. B. Robins. Torpedo boat destroyer No. 36, the *Patterson,* was authorized March 3, 1909, contract for building signed June 14 with the William Cramp & Sons Company, and was delivered Oct. 7, 1911, at the navy yard, Philadelphia. Principal dimensions are: Length between perpendiculars, 289 feet; molded breadth, 26 feet 4½ inches; depth, molded, 16 feet 4¾ inches; normal draft, 8 feet 4 inches; displacement, normal, 742 tons; block coefficient, 0.408. Propelling machinery consists of White-Forster oil-burning watertube boilers and Parsons turbines, five of which are arranged on three shafts. Propellers are three-bladed, solid manganese bronze castings, with faces of blades machined to true pitch. Diameter, 5 feet 3 inches; pitch, 4 feet 10.1 inches. There are four boilers arranged in two fire-rooms. Machinery arrangements, aside from main engines, are very much like the *Warrington* and *Mayrant,* reviewed in this number. 3,200 words with tables and plots of vessel's performance.—*Journal of the American Society of Naval Engineers,* November.

Twin-Screw Refrigerated Meat Steamer.—The steamer *El Zarate* has recently been completed by the Greenock & Grangemouth Dockyard Company, Ltd., for the Smithfield & Argentine Meat Company, Ltd. It is to be used for carrying meat down the River Plate to steamers carrying to British ports, and has been designed to the British Corporation specifications for river service. The general dimensions are: Length between perpendiculars 210 feet, 42 feet beam, 11 feet 3 inches molded depth to main deck. A bridge deck is added for 120 feet amidships, which, with the lower holds, gives space for insulated cargo to the amount of 60,000 cubic feet, which accommodates 400 tons deadweight. The hold is divided by five steel bulkheads. All compartments are thoroughly insulated by granulated cork and double thicknesses of tongued and grooved wood. Arrangements for loading are made so that all cargo may be loaded on trolleys without the

rehandling otherwise necessary. The refrigerating plant is sufficiently large so that half may be under repair and the other half keep the cargo at a suitable temperature. The propelling machinery is placed aft, and consists of two sets of compound condensing engines. Extra surface is supplied to insure high vacua at high temperatures of circulating water. Steam is supplied at 140 pounds pressure by two cylindrical multi-tubular boilers. Coal bunkers of large capacity are fitted alongside boilers. On trial the boat maintained a speed of 10.4 knots. 1,350 words, drawings and photograph.—*The Engineer, December* 15.

Marine Jet Propulsion.—By R. Kennedy. A thorough consideration of the forces involved and the most efficient means of employing them. Tells of the tests that were made on the *Water Witch* and why they failed. In this case pumps of very low efficiency were used, and the further mistake was made of stopping the flow of water through the vessel and imparting to it the velocity of the vessel itself. The loss for this is in some cases half the total available for propulsion. In looking for a system that might have a chance to prove its worth in competition with a screw propeller, the pump should show at least 80 percent efficiency. That centrifugals may now be designed even better than that is the author's belief. The one difficulty that is immediately apparent is the large entrance velocity required by the speed of the ship. This may be overcome by making the pump produce increased pressure, working within a Venturi tube, instead of producing increased velocity as is usually done when working in straight pipe. The increased velocity in this case results from the change in pipe size behind the pump and not in the pump itself. Pumps of this type may be arranged in series or multiple or both, depending on what velocity of jet and volume of water the design called for. Contrary to the usual belief, jets of same size as the usual propeller of the screw type are not required. The slower the ship the slower the velocity, and hence the larger volume to be moved. Therefore, the faster the ship the less water per ton of displacement is needed. The water carried within the ship is a serious consideration, and there is at present no way over this. The author thinks a fair test for the only scientific method of jet propulsion is yet untried, and tries to show that such a test would bring a successful solution. 4,800 words.—*The Engineering Review,* November 15.

The German Institution of Naval Architects.—An outline of the papers and discussions at the thirtieth annual meeting of the Schiffbautechnischen Gesellschaft, held at Charlottenburg on the 23d, 24th and 25th of November. This review is given in two instalments, and is of necessity of considerable length. Only those parts of most interest to marine engineers and naval architects will be touched on here, and even those only briefly. An interesting paper was "The Oil Motor in the German Sea Fisheries," by Prof. Romberg, of Charlottenburg. At first light oil motor car engines were used, but these were unsatisfactory. Engines of English make had had some success, but these had bad features. A prize was offered for the best design for an engine for such work, and a fairly satisfactory engine was the result. The main qualities needed were reliability, simplicity and small space requirements. Any complicated engine would suffer from rough treatment in these craft. Discussion on this paper was general and many good suggestions were offered. The next paper was "Studies and Experimental Work for the Design of My Large Oil Motor," by Prof. H. Junkers. The main problems to be solved were, he said, those of the transmission of heat and of the introduction of the charge in as cleanly a manner and at as low a temperature as possible. An important point was to design the combustion chamber as far as possible with unpierced walls. Protracted studies and experiment had led to the construction of an experimental double-piston, two-cycle, horizontal gas engine, which embodied the principles involved. The next step was to adapt this to the conditions of ship work. Plans and particulars were given of the engine being built for a ship for the Hamburg-American Line. The discussion of this paper was, as might be expected from a design so novel, very general, and several features were gone into extensively. Among others questioned were the unusual height of the frame and cylinders, stuffing-boxes, extra number of rods involved, all of which objections were answered by the designer. The next paper referred to the direction of turning of twin screws for best effect in maneuvering a vessel. An example was cited from the experience of the North German Lloyd, and endorsed by the experience of many present, that outward-turning screws were much more favorable to quick and efficient handling of a ship than inward turning. Another paper read was under the title, "Practical Results with Counter Propellers," by Dr. Wagner. The principle upon which this works is that of the water turbine, and when a counter propeller is placed just aft of the usual wheel the efficiency of propulsion is raised from 65 or 75 percent to 85 percent, and by further improvements even 90 percent might be realized. Experiments on small scale have shown this saving to be a real one. The next paper, and the last of importance, was by Herr H. Holzwarth, on "The Gas Turbine." As this paper has been reviewed from the original in our last month's instalment no further comment on it will be given. 12,000 words with photographs.—*The Engineer,* December 1 and 8.

The Suction of Vessels.—A consideration of the causes of the collision between the *Hawke* and *Olympic.* Model tests were made and reported by Mr. D. W. Taylor on the subject of the attraction of passing vessels at the Society of Naval Architects and Marine Engineers in 1909. These results are interesting in that they almost exactly corroborate the Teddington experiments following the recent accident. Although the subject is so large and the experiments made relatively few, some general results are suggested. These are, briefly, that as one ship passes another, when beginning to lap, the bow of the passing ship is attracted to the slower ship and the stern repulsed. When side by side a change takes place, and from that stage on the bow is repulsed and the stern attracted. If the two are in close proximity the rudder apparently does little good, this probably being the case with the *Hawke.* The intensity of these effects vary with the depth of water, size and block coefficients of the ships, width of channel or free water available and the speed of the ships. The case above mentioned was an extreme one, due to the great size of the *Olympic,* her speed and narrow channel in which they attempted to pass. 2,400 words.—*The Engineer,* December 22.

Approximate Stability.—By Arthur R. Liddell, Charlottenburg. Calculations of stability as usually made involve a good deal of laborious and tedious work. The author in this article makes use of approximate curves of righting levers, of which he gives tables and explains the method for obtaining and using. By assuming the 'midship section a rectangle, the righting levers are obtained in terms of the height of the block divided by the half breadth by means of six formulæ. These tables are given for an inclination of 30 and 60 degrees, and a short cut given for getting their values for 90 degrees inclination. From these tables values may be taken for their respective inclinations for any depth of block, and with the initial angle give sufficient points to plot a curve of righting levers. From this point on the process follows the usual course. Other applications than to transverse stability are then described briefly. 2,700 words, diagrams and tables.—*The Engineer,* December 15.

The Conversion of Niclausse into Babcock & Wilcox Boilers on the United States Ships Colorado and Pennsylvania.—By Commander C. N. Offley, U. S. N. This change was made by the Bureau of Steam Engineering on account of the high cost and difficulty of obtaining spare parts for the Niclausse boilers. Eight boilers were changed on each ship and the parts kept as spares for the remaining boilers. The actual work of changing the boilers was not a large part of the whole work, owing to part of the double bottom being renewed at the same time. The removal and replacing of stacks and uptakes was a large part. Article shows how the job was done by drawings and descriptions. 870 words.—*Journal of the American Society of Naval Engineers,* November.

Some Impressions of Continental Marine Diesel Engine Practice—No. I.—Description of a visit to the works of the Carels Frères, and more paricularly of their latest two-cycle marine oil engine developing 1,000 brake-horsepower. This engine is a four-cylinder reversible motor with cylinders 450 millimeters diameter and 560 millimeters stroke, turning at 250 revolutions per minute and weighing about 78 pounds per horsepower complete. Steel castings are used for bedplate and cylinder jackets and in other places. The process of starting is very simple, and is accomplished by use of three small levers. Control of speed after starting is accomplished by varying the delivery of fuel pumps. An improved engine has been already designed, and while the drawings were examined by the author no comments are printed. It is expected that many objectionable features in this older engine will be removed in the new. 2,450 words and photograph of the engine.—*The Engineer,* December 8.

Some Impressions of Continental Marine Diesel Engine Practice—No. II.—This instalment deals with what was seen at the Maschinenfabrik Augsburg-Nürnberg plant. Although this company has been building oil engines for twelve years it turned its attention to marine reversible engines only three years ago. Of single-acting engines two types are being made —heavy and light. The former are for ordinary commercial purposes, and weigh about 110 pounds per brake-horsepower, including all auxiliaries and thrust block. They are made in eight sizes, from 150 to 2,000 brake-horsepower, running from 300 down to 185 revolutions per minute for the two extremes. The standard engine of this type is six-cylinder and has no fly-wheel. The lightweight engines are designed for naval purposes, and are offered in ten sizes, running from 550 to 300 revolutions per minute. The total weight for this design is from 37 to 50 pounds per brake-horsepower, varying inversely with the size. The M. A. N. engines show very well the simplicity of the two-cycle type, and are provided with reversing and handling gear of unusually simple and effective design. One notable engine was shown of the double-acting type, which was of 850-1,000 horsepower, working at about 130 revolutions per minute. It had three cylinders of 18.9 inches diameter and 25.6 inches stroke. Arrangement has been made whereby for slower running the oil to the lower half of the cylinders may be cut off and the engine run single-acting. After a detailed account of the mechanism of the engines built by this firm the manner of reversing the two-cycle engine is explained in detail. 3,000 words and photographs.—*The Engineer,* December 15.

Some Impressions of Continental Marine Diesel Engine Practice—No. III.—This paper deals exclusively with a visit to the works of the Sulzer Bros. at Winterthur. The most space is given to the description of this firm's latest type of six-cylinder marine engine, followed by description of an installation in the twin-screw oil ship *Romagna.* The whole article is well illustrated with photographs and drawings, and well shows what has been accomplished by this one firm in a new line of marine engineering. The general impression received at the works is that the largest jobs are handled there as a matter of everyday occurrence. Surely a great variety of work is turned out. One engine seen was a single-cylinder motor designed to give 2,000 horsepower at the brake, and at the same time there was being built a three-cylinder engine for 35 horsepower at 450 revolutions. The latest Sulzer six-cylinder motor is two-cycle, and gives 300 brake-horsepower at 500 revolutions per minute. It has scavenging and compressed air pumps at the forward end of the crankshaft. The scavenging air valve is placed at the bottom of the cylinder, operated by a tappet without the intervention of a rocker. Repeated experiment has shown that this placing of the valve is as conducive to efficiency as the usual one in the head of the cylinder. The cams operating the fuel and compressed air in the head of the cylinder are run in oil, greatly reducing the noise. Trunk pistons are used and the bottom of the engine is enclosed. The bedplate is of bronze, while aluminum is used to some extent for doors, etc. The Italian mail boat *Romagna* is 175 feet long, 25 feet of beam and 12.6 feet in depth, with a displacement of 1,000 tons. She has two 800-horsepower motors, which take up a very small space in the hull. On trial, it is said, she did 12.4 knots, and thorough maneuvering tests were satisfactorily carried out. It is reported that in actual service the governor kept the engines under control in heavy seas. 3,000 words.—*The Engineer,* December 22.

Superheated Steam at Sea.—By P. C. Ashford. A review of the situation in marine engineering of the case of the superheater. Although the resulting economy from the use of superheaters has been known for fifty years, their use was not extensively adopted because of the difficulties attendant upon their practical operation. Thus at first there was difficulty in the design of a suitable superheater. Afterward, difficulties with oil in feed water, salt leaking through condensers into the feed and other minor troubles caused owners and builders to overlook the economy to be obtained. Within the last few years these difficulties have been overcome, and the future of the superheater for marine service is bright. Many small installations are in operation as well as some as large as 20,000 horsepower in the German and United States navies. The extensive introduction of turbines revived interest in superheaters, for though a smaller economy is given when used with turbines the troubles are practically nil. The Schmidt type is one commonly used with Scotch boilers and the Babcock & Wilcox with watertube boilers. The article gives tables of data showing the economy obtained from various degrees of superheat with both types, together with numerous illustrations of them in boilers of different kinds. 2,600 words.—*Cassier's Magazine,* November.

A New Horsepower Calculator.—By Commander U. T. Holmes, U. S. N. A useful instrument for shipboard where many horsepower calculations must be made. Based on the expressions $H.P. = \frac{P \times R}{k}$, or $H.P. \times k = P \times R$, and making use of logarithmic scales on the principle of the slide rule. The instrument is adaptable to different engines by changing the position of the rule on which is marked the value of the k. Scales for converting mean effective pressures into equivalent mean pressures, and for showing values of moments in the Denny-Johnson torsion-meter shaft corresponding to angular deflections of the shaft as measured, are shown on the same board. The device was arranged by Lieutenant-Commander L. F. James, U. S. N., and it has become a part of the equipment of the engineering laboratory at the Naval Academy as well as of the engine rooms afloat. 1,800 words with several illustrations.—*Journal of the American Society of Naval Engineers,* November.

INTERNATIONAL MARINE ENGINEERING

Published Monthly at

17 Battery Place New York

By MARINE ENGINEERING, INCORPORATED

H. L. ALDRICH, President and Treasurer

Assoc. Member of Council, Soc. N. A. and M. E.

and at

Christopher St., Finsbury Square, London, E. C.

E. J. P. BENN, Director and Publisher

Assoc. I. N. A.

HOWARD H. BROWN, Editor

Member Soc. N. A. and M. E.; Assoc. I. N. A.

AMERICAN REPRESENTATIVES

GEORGE SLATE, Vice-President

E. L. SUMNER, Secretary

Circulation Manager, H. N. DINSMORE, 37 West Tremlett St., Boston, Mass.

Branch Office: Boston, 643 Old South Building, S. I. CARPENTER.

Entered at New York Post Office as second-class matter.

Copyright, 1912, by Marine Engineering, Inc., New York.

INTERNATIONAL MARINE ENGINEERING is registered in the United States Patent Office.

Copyright in Great Britain, entered at Stationers' Hall, London.

Notice to Advertisers.

Changes to be made in copy, or in orders for advertising, must be in our hands not later than the 15th of the month, to insure the carrying out of such instructions in the issue of the month following. If proof is to be submitted, copy must be in our hands not later than the 10th of the month.

As shown on another page of this issue, nearly every maritime country in the world has shown a remarkable increase in the amount of shipbuilding and marine engineering carried out in 1911. Not only have the records of the leading shipbuilding centers been exceptional, but the rate of increase in the smaller maritime nations has, in many cases, been abnormal. Naval work, of course, in many cases predominated; but, aside from that, the remarkable records made were due principally to the widespread expansion of over-sea trade and the consequent upbuilding of the world's merchant marine. At the present time reports from Lloyd's show that the figurès for the tonnage under construction in the United Kingdom for the last quarter are the highest ever recorded by the society, being 5 percent greater than the preceding quarter and 30 percent greater than that for the corresponding period last year. With such prospects and with the forthcoming readjustment of maritime commerce by the opening of the Panama Canal, shipbuilding and its allied industries cannot fail to maintain an unprecedented era of activity.

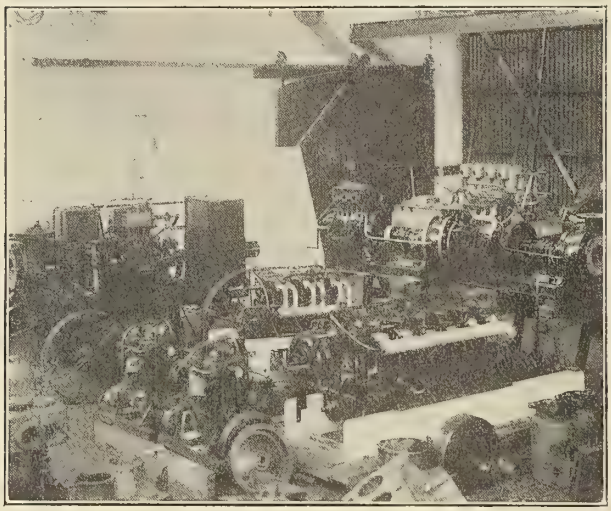
The McAllister plan for assessing tolls on vessels making use of the Panama Canal seems to have been very favorably received, not only by members of the Congressional committee investigating the subject, but by many others who have given thought to the question of tolls. This plan, as laid before the committee by Captain C. A. McAllister, engineer-in-chief of the Revenue Cutter Service, proposes to do away entirely with the usual plan of assessing tolls on the net tonnage of all vessels with the various exceptions and conditions necessitated by the different types of vessels. It proposes to have every ship entering the canal measured, as to length, beam and draft at the waterline, so as to secure its so-called block displacement. It would take but a short time to make these measurements and to figure exactly the number of cubic feet in the block determined by these dimensions. The toll is to be a fixed amount per cubic foot of block displacement. The possibility of there being some injustice to a fast ship of fine lines with a comparatively small carrying capacity, and the rules being particularly favorable to steamers of the tramp type, is believed to be overbalanced because of the much higher freight rates the ship of finer lines would charge. In whatever way the question may be viewed, the unfairness which accompanies the usual methods of assessing canal tolls is obviated, and the proposed plan is commendable for its simplicity.

One of the innovations in marine engineering which has made a rapid advance in recent years is the use of the small steam turbine for driving auxiliaries. The initial steps in this direction were, of course, limited, and it required time to work out the adjustments necessary to adapt the machine to its peculiar requirements on board ship. The many years which had been spent in the perfection of small reciprocating engines for this service left a small margin of improvement for the turbine to show its superiority. The adaptation of the turbine drive to ship auxiliaries, however, was more closely related to similar installations on shore than, for instance, was the use of the turbine in large units for ship propulsion, and, consequently, the experience gained from the wide use of the turbine-driven auxiliaries on shore did much to develop this type of turbine for marine work. The result has been that small steam turbines are now being used, to a great extent, on both merchant and naval vessels for driving electric generating sets, forced draft blowers, rotary air pumps and air compressors. A more recent use of the turbine, and one which promises to be of considerable advantage, is the develment of turbo circulating and feed pumps. Installations of such character frequently require the use of machines developing several hundred horsepower at the brake. To accomplish this, and to take the place of economical reciprocating engines, it is necessary that the small turbine show a good performance in the question of steam consumption. It is gratifying to note that good results in this direction are now obtainable.

Improved Engineering Specialties for the Marine Field

Brooke Gasolene (Petrol) Engine

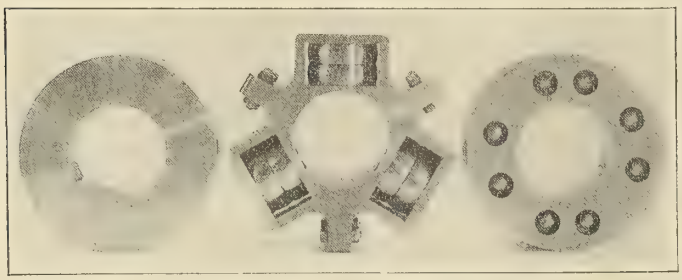
The variety of uses for which the Brooke internal-combustion engines are made is shown in the accompanying illustration, a view which was taken in the corner of the finishing shop. The trolley shown on the left is fitted with a 12-horsepower Brooke motor, one end of which drives a centrifugal pump and the other end a belt pulley. Beyond this apparatus



are two 12-horsepower centrifugal pumping sets and a 45-horsepower motor. In the foreground is a 65-horsepower marine motor, a 4-horsepower pumping set and a 25-horsepower six-cylinder motor, also a 4-horsepower electric lighting set. These equipments are manufactured by J. W. Brooke & Company, Ltd., Lowestoft, and they are all destined for shipment to foreign countries.

Planet Thrust Bearings

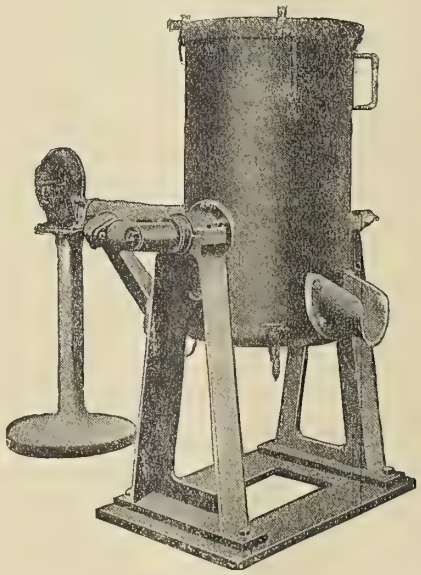
Roller or ball bearings for taking end thrust have proved successful, but there are some features in connection with the design of the bearing which have to be considered. It is impossible to produce a mechancial coupling in a single ball where the load is transmitted through the ball to two plane surfaces. In the thrust bearing made by the Planet Engineer-



ing Company, New York City, the three-point support avoids intermediate stresses due to inequality of size or the presence of grit. Since the load-carrying capacity of a ball increases as the square of the diameter, the design of the Planet bearing, it is claimed, allows a larger diameter than any other type of ball or roller bearing. The details of design concerning the support and mounting or housing of the bearing surfaces are matters which can be determined by the designer of the apparatus, and the manufacture of such parts is within the scope of ordinary machine shop practice. But it is not practical for the ordinary manufacturer to make steel of the requisite quality, nor are many machine shops equipped with precision tools to grind the steel to the accurate dimensions required. These are matters which can be taken care of by the product of the Planet Engineering Company, and the details can be worked out for a variety of uses.

Green's Emergency Cupola

The furnace illustrated was designed for making castings which are urgently needed for breakdown work or for test mixtures or for pouring castings which have missed or cannot wait for the next blow from the ordinary cupola. The need of such an auxiliary in ordinary foundry work is apparent, but the casting must be done quickly and satisfactorily. In this furnace the blast is admitted through two hollow trunnions which form the tuyeres. There are two suitable bend pipes fitted with sight holes, so arranged that any slag which may find its way into them may be removed readily



without causing a choking up of the blast pipes. To the two bend pipes is coupled a suitable Y-shaped pipe, which connects the fan to the furnace and which is fitted with a suitable blast gate. The blast fan is mounted as shown in the illustration, and requires about one-half horsepower for operation. The furnace is fitted with a drop bottom and two pouring spouts, the top spout being available in event of the bottom one becoming choked with chilled iron or slag. The lining of the furnace is of ganister. When in operation molten metal pours out the spout in from eight to ten minutes after setting on the blast, and it is reported that 20 cwt. heats are melted daily, and sometimes 40 cwt. heats, with satisfactory results. George Green & Company, Keighley, are the manufacturers of the cupola.

A New Propeller Material

Monel metal, which is a "natural alloy" that is regarded as a successful substitute for steel and bronze, has recently been cast in pieces weighing as much as 25,000 pounds. Most of these large castings have been for propellers that are furnished to the United States Government in accordance with standard specifications for this metal. The demand for wheels

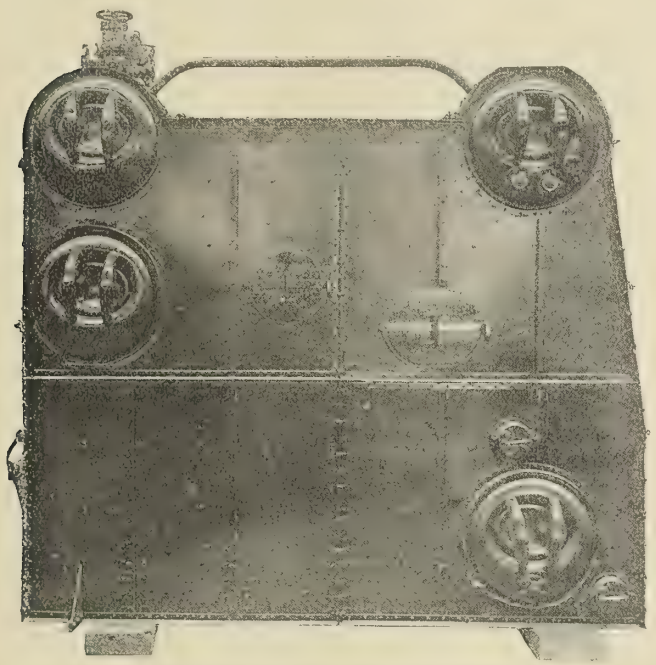
of this metal is increasing, which is indicative that it possesses unusual qualities that make it extremely suitable for this purpose.

One of the most prominent of the naval vessels that has been equipped with propellers of this metal is the Argentine Republic's huge battleship *Rivadavia* recently launched at the Fore River shipyard. It has three propellers, and all are made of Monel metal and three-bladed, each casting weighing 16,000 pounds.

Two spare wheels of 18,000 pounds each have also been made for the *North Dakota*, while four propellers, each weighing 8,000 pounds, have been cast for the *Florida*. These last are of the three-bladed design, which is preferred for high-speed vessels, though when the diameter is unduly restricted four or more are used.

Many torpedo boat destroyers are now fitted with Monel metal propellers. The more important of those propelled by a three-bladed design weighing 2,000 pounds each are the *Terry, Roe, Sterrell, Perkins, Walke* and *Fanning*.

Heretofore propellers have been made largely of various kinds of bronze, particularly manganese bronze; the qualities that have made manganese bronze suitable for this use are its



EXTERIOR OF BADENHAUSEN MARINE BOILER, SHOWING THE CASING AND MANHOLES

ability to resist shock and its resistance to salt water corrosion; but with the rapid development of the marine turbine the demand for a propeller material that would stand even better the severe shocks of high-speed service has become manifest. With the idea in view of using Monel metal as a substitute for bronze various tests were made on propellers cast of this material. The results were surprising, and at first were thought to be due to increased tensile strength, yield point and the retention of its high polish without corrosion or pitting, for Monel metal takes a finish like pure nickel. The most probable of these appeared to be the last, as the increased tensile strength over that of manganese bronze would only indicate an increase of the factor of safety and resistance to shock rather than resistance to stresses within the elastic limit. Careful experiments with a testing machine on a large number of samples demonstrated that the remarkable results were due to the modulus of elasticity. Manganese bronze has a modulus of elasticity of 13,000,000; Monel metal, 22,000,000 to 23,000,000, and steel 28,000,000 to 32,000,000. All metals, of course, distort inside the elastic limit and recover again when the stresses are removed, but it will be noted that the distortion with Monel metal is less than with manganese bronze. With distortions come changes of pitch and consequent losses of efficiency.

From a practical standpoint the following tests, made in duplicate, from test pieces cut from one of the blades for one of the 16,000-pound propellers for the *Rivadavia*, are interesting as showing both the strength and uniformity of this new metal:

TESTS ON MONEL METAL PROPELLERS

Laboratory of Wm. Sellers, Inc., Philadelphia, Pa.

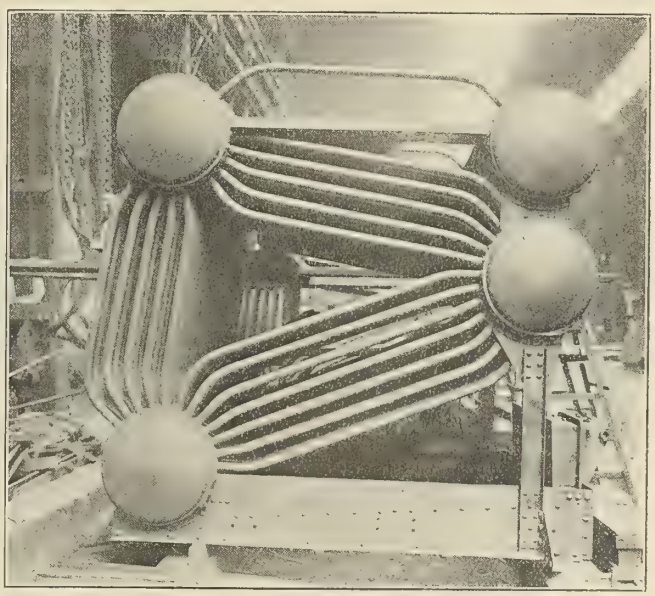
	Pounds Per Square Inch. Yield Point.	Tensile Strength.	Elongation in 2 ins.
First blade	38,806	82,580	45%
Second blade	35,820	81,570	45
Third blade	37,500	86,500	45

Laboratory of the Orford Copper Company, Bayonne, N. J.

	Pounds Per Square Inch. Yield Point.	Tensile Strength.	Elongation in 2 ins.
First blade	37,500	82,500	45½
Second blade	37,500	82,250	44
Third blade	37,250	83,500	33

The Badenhausen Watertube Marine Boiler

An all-steel watertube marine boiler, with no hand-hole plates, flat surfaces, stay-bolts, cast metal or screwed joints, is manufactured by the Badenhausen Boiler Company, 90 West street, New York City. The boilers are built in large units, so designed as to occupy minimum space. The arrangement consists of three or four drums connected by tubes. The large mud-drum, full of water at the point where water is most



BADENHAUSEN MARINE WATERTUBE BOILER

needed, means that the steaming tubes are well supplied with water under all conditions, so that the boiler can be forced to an exceptional degree. Boilers of this type, it is claimed, have been operated at 250 percent of normal rating at long periods of time. Every tube discharges its full opening directly into the steam drum, thus delivering the mixed steam and water with the least possible disturbance. Access to the interior of the boiler is given through the drum man-holes. No hand-holes, plates, dogs, nuts or gaskets are used, so that the possibilities of leakage and failures are reduced to a minimum. The tubes are slightly bent, so as to enter the drums radially, and are cleaned by means of mechanical tube cleaners. The outside of the tubes can be cleaned from the front of the

boiler by means of a steam lance. The construction of the boiler admits replacing the tubes from the front of the boiler as well as cleaning and blowing them from the same position. The baffling can also be done in a simple manner, as no special shapes are required.

Advances in steam engineering have now placed boiler design under new conditions, since it has been found that well-designed boilers can be operated economically at at least double rating, and even more, and that large units can be used to better advantage than a great number of small units. The Badenhausen boiler has been designed to meet these conditions.

Anchor Bushes

Air pump and other valves, whether hard or flexible, have frequently to be discarded before the body of the valve is worn out, owing to the enlargement of the central hole, Fig. 1, which is brought about by the wear caused by the vertical

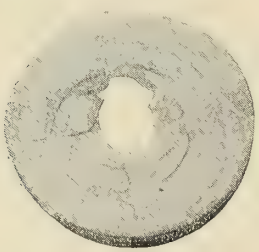


FIG. 1

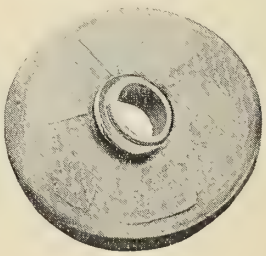


FIG. 2

movement on the stud. Remedies for this difficulty which have frequently been used have been bushing the valves and vulcanizing the bushes into the valves, but continued use has resulted in subsequent breakdowns, as shown in Fig. 2. A new

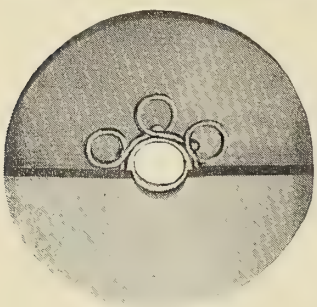


FIG. 3

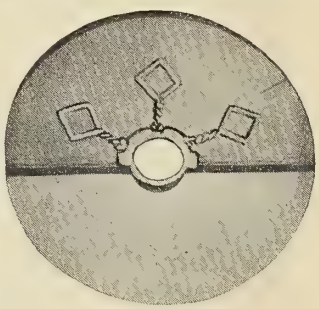


FIG. 4

method of overcoming this difficulty has been devised by the Dermatine Company, Ltd., 93 Neate street, London, S. E., in the development of what are called "anchor" bushes. As shown in Figs. 3 and 4, the bush is embedded and vulcanized into the valve in such a manner as to prevent loosening. In the case of anchor bushes for flexible valves, Fig. 3, the arms, being hinged, allow the valve to "saucer" readily, and with hard valves, Fig. 3, there is just sufficient flexibility with the wear loop to prevent the beat on the seating and to guard from cracking the valve.

Marine Steam Turbines, by Dr. G. Bauer and O. Lasche, assisted by E. Ludwig and H. Vogel, and translated from the German and edited by M. G. S. Swallow, which was reviewed on page 42 of our January issue, is being published in the United States by the Norman W. Henley Publishing Company, 132 Nassau street, New York city. The price of the American edition is $3.50 net.

Technical Publications

Thermodynamics of the Steam Turbine. By Professor C. H. Peabody. Size, 6 by 9 inches. Pages, 282. Illustrations, 103. New York, 1911: John Wiley & Sons. Price, $3.00 net (12/6).

Most of the books on steam turbines which have been published, and a good many of them have been published in the last few years, have been largely of a descriptive nature, describing briefly the principles of action and the details of construction of the various types of turbines. Those who have attempted to study the subject with a view to designing, constructing or operating turbines have usually been at a loss to find any accurate treatise on the thermodynamics of this type of engine. For this reason, Professor Peabody's book stands practically alone, in that it is devoted entirely to the application of thermodynamics to steam turbines. The book was written particularly for the use of students in technical schools, and the author assumes that those undertaking such work will have a good preparation in general thermodynamics. A brief resumé is given in the first chapter of the properties and computations for steam, and then the study of the computations involved in steam turbine design are taken up in complete form. The book includes chapters on steam nozzles, jets and vanes, simple impulse turbines, pressure compounding, velocity compounding, pressure and velocity compounding, reaction turbines, accessories, effect of conditions, and marine steam turbines. The author states that the methods given are in general those accepted by steam turbine designers, but that certain methods have been devised by the writer either to make the methods more complete or to provide more rapid and precise determinations of conditions and proportions. The subject is treated very clearly, and in such a manner that little other instruction is necessary for the reader to thoroughly understand the subject.

Fore and Aft. The story of the fore and aft rig from the earliest times to the present day. By E. Kreble Chatterton. Size, 9¾ inches by 7 inches. Pages, 347. London: Seeley Service & Company. Price, 16s.

Mr. Chatterton has followed up his "Sailing Ships and Their Story" with the present well-illustrated and popularly instructive volume dealing with the evolution of the fore and aft rig. The present work contains only a few pages less than the bulky volume which dealt with all types of sailing vessels. The author is a thoroughly experienced yachtsman and adores his subject; in an interesting preface he says that his "joy and delight when voyaging in any kind of sailing vessel is intensified a thousandfold when he knows her ancestry." His aim in the present volume is to follow in detail the history and development of fore and afters, and for this purpose he has investigated the subject very fully. He traces, step by step, how different countries and different localities have adopted this rig to suit their special requirements. As the fore and aft craft is the only type of sailing vessel which is increasing, the present work is likely to be of permanent value to men in any way interested in yachts. There are altogether 130 illustrations, the arrangement of the volume is particularly attractive, and is a credit to the publishers.

Gas Engine Theory and Design. By A. C. Mehrtens, M. E. Size, 5¼ by 8 inches. Pages, 251. Illustrations, over 200. New York, 1909: John Wiley & Sons. Price, $2.50.

To present the theory and the "why" of many things connected with gas engines in such form that students, draftsmen and engineers, and also men who operate gas engines of any kind, can understand them and apply their knowledge, was the aim of the author of this book, who prepared it principally

for use as a textbook in an engineering school. In such a small volume it is, of course, impossible to give a complete discussion of the thermodynamics of the gas engine, but as far as space allows the actual conditions of theory and design are given. Readers of this book will find of particular value the part which takes up the design and dimensions of parts of gas engines, which contains information which it is usually difficult to obtain except from practical experience.

Shipyard Practice as Applied to Warship Construction. By W. J. McDermaid. Size, 6 by 9 inches. Pages, 328. Numerous illustrations. London and New York, 1911: Longmans, Green & Company. Price, 12/6 net.

This work embraces a course of lectures given by the author to cadets of naval construction at the Royal Naval College. They are of a very practical nature, and, with the very complete illustrations, give the reader a splendid opportunity to learn how the actual work of construction of warships is carried out in a shipyard. This is the kind of information which is usually acquired only by actual work in a shipyard, and therefore a practical treatise of this kind is a most convenient source of information for the student of naval architecture and shipbuilding.

Power Plant Testing. By James Ambrose Moyer. Size, 6 by 9 inches. Pages, 422. Illustrations, 271. New York, 1911: McGraw-Hill Book Company. Price, $4.00 net.

One of the most important fields of work for an engineer is the testing of power plants, but the study of this work has usually been confined to laboratory work in technical schools. On account of the value of the work a volume containing a careful treatise of the methods of testing various kinds of machinery is of considerable value. The ability to make careful and reliable tests from which accurate data can be obtained for guaranteeing the performance of various kinds of machinery is one of the most valuable assets of an engineer. The work is of very broad scope, however, and accurate information regarding the measurement of different factors is necessary. Measurement of pressure, temperature, area, power, flow of fluids, calorific value of fuels, gases, etc., involve different procedures and the use of different instruments. These are all treated by the author in such a way as to be useful not only to students but also to practical men, so that those who have not had the privilege of professional training can become familiar with the up-to-date methods of testing.

Electrical Propulsion of Ships. By H. M. Hobart. Size, 5½ by 8½ inches. Pages, 167. Illustrations, 43. London, 1911: Harper & Bros. Price, 5/ net.

Electric propulsion, while strongly advocated, has as yet seldom been adopted except in small powers. The possible difficulties of its use have so far outweighed its many evident advantages. A great deal of information has been published on this subject in current engineering literature and comprehensive papers have been presented before engineering societies. Bids have been made for large installations for both naval and merchant marine work, therefore the interest in this subject warrants the publication of a work which is largely a condensed statement of the various articles which have been published on this subject. While the author of this book, we understand, is engaged in electrical engineering work, he has not attempted to present any particular work of his own, but has obtained his information and conclusions from the available material on this subject. The book has been written in a very instructive and readable manner, and should be of much interest to those engineers who are not very familiar with electrical work and would like to know what the main features and possibilities of this method of propulsion are.

Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,003,063. SUBMARINE OR SUBMERGIBLE BOAT. EDWARD LASIUS PEACOCK, OF BRIDGEPORT, CONN.

Claim 1.—A submarine or submergible boat, having a deck provided with an adjustable section that is adapted for adjustment whereby one end of said section may be elevated or lowered out of horizontal alinement with the fixed section of the deck to present inclined surfaces to the water when the boat is operating submerged. Fourteen claims.

1,003,364. BOAT CONSTRUCTION. FREDERICK B. LANGSTON, OF NEW YORK, N. Y.

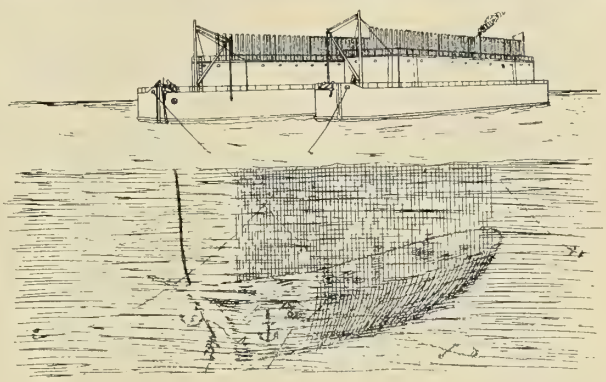
Claim 1.—In a boat construction, a hull having an under supporting surface; a plurality of parallel, fore-extending side plates projecting beneath said supporting surface; an upwardly inclined fore skidding member with its rear lower edge depressed below said supporting surface and cross-connecting said side plates; and an aft skidding member with its under surface inclined aftwardly and downwardly from said supporting surface and cross-connecting said side plates, every cross section through the under surfaces of both said skidding members being a horizontal straight line. Seven claims.

1,004,552. SUBMARINE SALVAGE APPARATUS. HARRY LIVINGSTON BOWDOIN, OF NEW YORK, N. Y.

Claim 1.—A submarine salvage apparatus, consisting of a strongly-built chamber, means for providing a circulation of air for breathing purposes in said chamber, means for raising and lowering the apparatus, ball and socket universal bearings in the walls of said chamber, tools operated through the bearings from the inside, a cable for supplying electric light and power within said chamber, magnetic arms attached to said chamber, and suitable means of propulsion through the water and on the bottom. Three claims.

1,005,408. DEVICE FOR RAISING SUNKEN VESSELS. CHAS. H. BROWN, OF LONGBEACH, CAL.

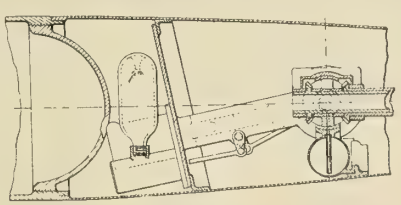
Claim 1.—A barge of he class described having cable ways formed therein and disposed at intervals along the length of the barge, cable



receiving trunks extending in an inclined direction from said cable ways and carriers extending between said cable ways, and trucks adapted to carry cables between the same. Seven claims.

1,005,647. MEANS FOR THE PROPULSION OF AUTOMOBILE TORPEDOES. ALBERT EDWARD JONES, OF FIUME, AUSTRIA-HUNGARY, ASSIGNOR TO MESSRS. WHITEHEAD & CO., OF FIUME, AUSTRIA-HUNGARY, A CORPORATION.

Claim 2.—A torpedo having a propeller shaft provided with a propeller, a motor, a driving mechanism connecting the motor to the shaft,



and an oil reservoir symmetrically disposed at each side of and below the propeller shaft and having a feed pipe leading to the said mechanism. Ten claims.

1,006,044. ELEVATOR FOR MARINE VESSELS. HARRY BARLOW, OF SEATTLE, WASH.

Claim 1.—In an apparatus of the class described, the combination with the hull of a vessel provided with an upper and lower deck, the upper of said decks having an opening therein, of a vertically movable platform formed of a series of planks and angle bars, guide pulleys located

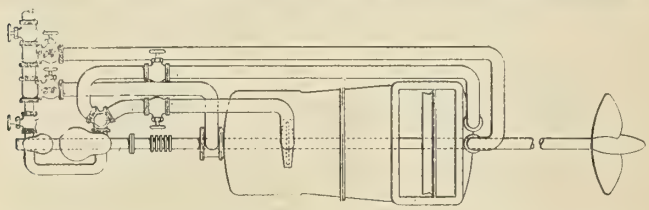
below the lower deck, supporting posts, guide pulleys upon said posts, cables connected to said platform and traveling over said guide pulleys, and means whereby said cables are actuated for hoisting and lowering said platform, certain of the beams of the lower deck being provided with notches for the reception of said angle bars when the platform is lowered against the lower deck. Two claims.

1,006,212. TORPEDO-TUBE CAP. HARRY HERTZBERG AND MAURICE J. WOHL, OF BROOKLYN, N. Y., ASSIGNORS TO ABBOT A. LOW, OF HORSESHOE, N. Y., AND MAURICE J. WOHL AND HARRY HERTZBERG, OF BROOKLYN, N. Y., TRUSTEES.

Claim.—In combination with a submarine vessel having an opening at one end thereof, of a torpedo tube having its mouth filling said opening, a hinged cap having a thickened central portion and provided with a gear attached thereto outside of said vessel and arranged to cover said opening and the mouth of said torpedo tube, the exterior surface of said cap being formed to conform to the exterior surface of the vessel, the said surfaces together providing a continuous uniform exterior surface for the vessel when said cap is closed, a shaft extending from the outside to the inside of said vessel and provided with a worm at the outer end thereof meshing with said gear, and a means positioned within said vessel for rotating said shaft and worm to operate said cap.

1,006,674. MARINE PROPULSION. CHARLES ALGERNON PARSONS, OF NEWCASTL-UPON-TYNE, AND STANLEY SMITH COOK, OF WALLSEND, ENGLAND; SAID COOK ASSIGNOR TO SAID PARSONS.

Claim 1.—In combination in a marine turbine installation, means connecting two portions of a shaft, said means producing a thrust which



is proportional to the torque transmitted between the shaft portions and which acts to balance the propeller thrust.

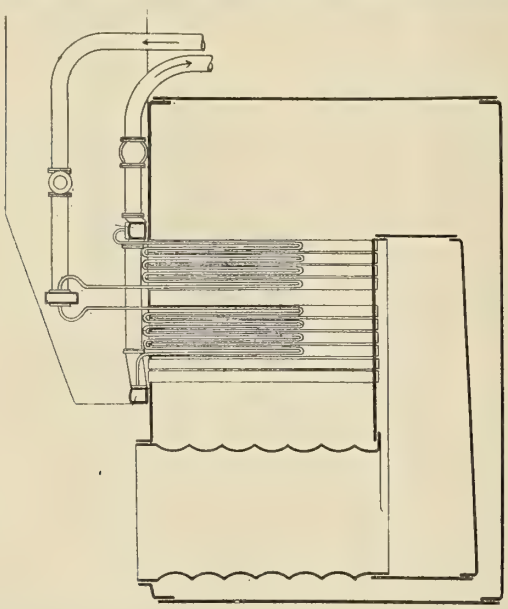
1,006,380. VENTILATING APPARATUS FOR SUBMARINE VESELS. HARRY HERTZBERG, OF NEW YORK, ABBOT A. LOW, OF HORSESHOE, AND MAURICE J. WOHL, OF NEW YORK, N. Y.; SAID HERTZBERG, LOW, AND WOHL ASSIGNORS TO THEMSELVES, TRUSTEES.

Claim.—In a submarine vessel, in combination, a conning tower, a ventilating device positioned in front of said conning tower, a ventilating device positioned in the rear of said conning tower, said ventilating devices each comprising a tube extending upwardly from the interior to the exterior of the vessel, the tubes of each device having the upper end flaring and extending in opposite directions toward the ends of the vessel, and cup-shaped receptacles inclosing the lower ends of said tubes into which the air is received and also any water which may enter the tubes, said cup-shaped receptacles being provided with air outlets above the lower ends of said tubes and also with means for removing the water therefrom.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C. London.

12,633. STEAM SUPERHEATER FOR MARINE BOILERS. A. O. P. FREDERIKSEN, COPENHAGEN.

This superheater is characterized by a box, for distributing saturated



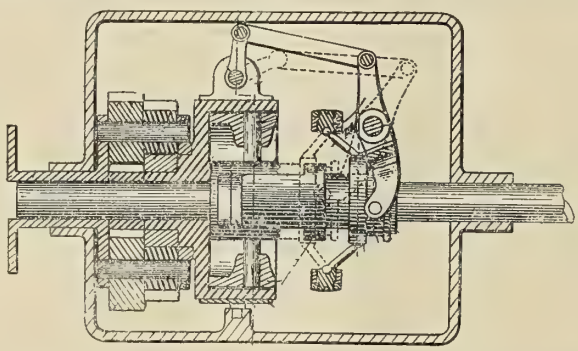
steam, located opposite the center of the boiler smoke tubes and fitted with superheater tubes. These are placed between the distributing box and steam-collecting boxes, located along the upper and lower edges of the smoke tubes.

7,432. TUBES, MASTS, ETC. A. SIEWERT, BERLIN.

There has lately arisen a demand for tubes of increased diameter and supporting power for telescoping masts, etc. This invention relates to a tube of polygonal cross section, and the novel construction and arrangement consists in that it is composed of separate rods or strips, one of which engages the next adjacent by means of projections which pass through slots in the latter.

13,419. MARINE CLUTCH AND REVERSING GEARING. C. S. HOOK, TORONTO.

The engine is coupled to a sleeve loose on the propeller shaft and carrying the reversing pinions. A drum like the sleeve also rotates on the shaft, when reversing. In running forward, the drum is locked to the shaft by shoes which engage its rim from within, being thrust apart by



cams operated by toggles and a slide on the shaft. The lever which operates the slide also works links and a crank which, in another position when the shoes are withdrawn, clasps a band tightly around the outside of the drum to hold it so that the pinions are caused to rotate and so reversely turn the propeller shaft. This arrangement gives a positive forward drive.

14,216. HYDROPLANE BOATS. H. M. VAN WEEDE, VIENNA.

This invention is characterized by forming the hull of an arched shell open at bow and stern with the crown sloping downward from stem to stern, so that air taken in at the larger front end of the arch will be compressed as the boat moves forward because of the reduction in the cross sectional area of the arch towards the rear, with the result that the boat will skim along the surface of the water. Horizontal fins are provided for controlling the depression or trim of the boat whilst air tubes are used to float it.

19,210. INDICATING VARIATIONS IN DISPLACEMENT. S. S. STRONG, LIVERPOOL, FROM T. M. MACFARLANE AND J. R. DOUGLAS, ON THE HIGH SEAS.

In this apparatus a tube contains a float and is placed amidships and in communication with the sea. The float is connected by a cord to a slipper on guide, and which is attached to a band connecting it with

the counterweight of the indicator—a vertical scale and slipper guide and slipper. Thus the motoon of the first slipper is magnified at the second slipper.

21,948. SUBMARINE MINES. G. E. ELIA, PARIS, THROUGH VICKERS, SONS & MAXIM, LTD., LONDON.

The mechanism for exploding the mine is attached to a loose rope which floats in the tideway beneath the surface so that a ship's propeller may become entangled in it and so explode the charge, also submerged and in the form of a boom. This boom is maintained at a constant depth by means of a hydroplane fast to an anchor cable. Two such booms are connected by a cross rope so that the bow of a ship may draw them to her side, when the tension on the cross rope will explode the booms should the trailing ropes fail to become entangled. In a modification the anchor contains the explosive and the firing mechanism, and is likewise drawn to the ship's side before detonation.